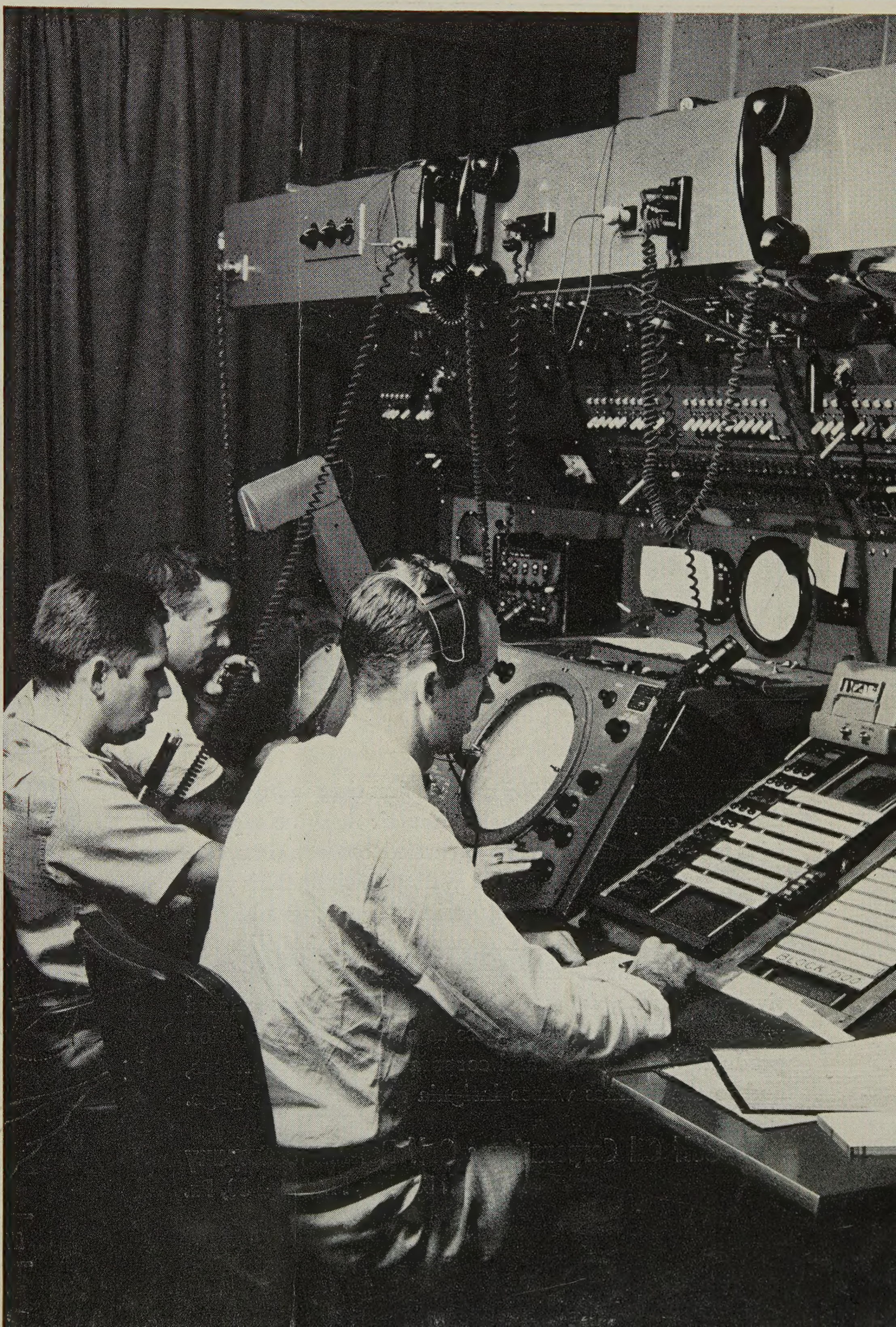
Skyways

Flight Operations
•
Engineering
•
Management



Evaluation:
C-W C-124A
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Take-Off

OBER 1953 50c

OCTOBER, 195[illegible]

Skyways

Flight Operations • Engineering • Management

COVER: IFR Team at N. Y. International Airport

FOUNDED BY J. FRED HENRY, 1942

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...now hear this

PERSONNEL

Admiral John H. Towers (USN Ret.) was elected President of Flight Safety Foundation, Inc. Adm. Towers, who retired as vice president of Pan American World Airways in 1952, has been acting as a consultant to that company. Jerome Lederer, Managing Director of Flight Safety Foundation, will continue as active director.

A. V. Leslie has returned to TWA as Vice President-Finance and Treasurer. Mr. Leslie replaces Earle Constable, treasurer of TWA since 1950, who resigned to accept an executive position with an aircraft manufacturing company.

Thomas F. Armstrong has been elected to succeed Capt. Eddie Rickenbacker as President of Eastern Air Lines. **Capt. Rickenbacker** was elected Chairman of the Board and he still retains his position as Chief Executive Officer and General Manager of EAL. **Thomas Creighton** was elected to succeed Mr. Armstrong as Treasurer, and **Floyd Farley** was named Secretary of the corporation.

Chet Pearson, Beech Aircraft's vice president in charge of manufacturing, recently was elected to the corporation's board of directors. **James N. Lew** was named vice president in charge of contract administration, and **Lynn D. Richardson** was named vice president in charge of military sales. In the reorganization of Beech Aircraft's engineering division, **A. S. Odevseff** was named to head Beechcraft's military projects engineering section, and **Herb Rawdon** has been put in charge of Beech's commercial projects engineering section. **Dean Burleigh** directs Beechcraft's administration and statistical engineering section.

Clarence I. Rice is now manager of aviation sales for Bendix Radio Communications Division. In the Bendix Products division, **Frank E. Bremer** was named Service Manager. He will be in charge of Bendix national and world-wide service organization.

Lear, Inc. recently appointed **Gordon Israel** Chief Aircraft Engineer. Mr. Israel will work closely with William P. Lear in the design of the *Learstar*, a Lear modified version of the Lockheed *Lodestar*.

George B. Meyer has been appointed manager of the electronics section for aviation products of Westinghouse Electric Corp. He is based at Westinghouse Electric's Dayton office.

Sanford B. Kauffman, assistant chief engineer of Pan American World Airways since 1946, was elected assistant vice president-engineering recently and **Capt. Wilbur W. Lynch** was elected assistant vice president-communications. **Josiah Macy, Jr.** was appointed assistant secretary of Pan Am.

Rollin M. Russell, executive engineer in charge of Pacific Coast operations of Continental Aviation & Engineering Corporation, Detroit, has been named manager of the company's Turbine Division.

Allegheny Airlines has appointed **Luke L. Hilliard** as Director of Communications. Before joining Allegheny, Mr. Hilliard was an electronics engineer with Collins Radio.

COMPANIES

Lockheed Aircraft Service has established new offices at Washington (D. C.) National Airport. Thomas T. Hinman, military relations manager, will continue in charge of LAS activities.

Champion Spark Plug Co. has announced a reorganization and enlargement of its aviation department. **R. L. Anderson** has been named aviation sales manager; **Earl Koehler** remains as Champion's aviation representative on the West Coast, while **Russell Biegel** will cover the Midwest and **Harry Archer,** the East Coast area. **Burns R. Maus** will continue as Champion's special aviation representative.

Continental Aviation & Engineering Corp., a subsidiary of Continental Motors Corp., has begun construction of two new buildings in Detroit. The new buildings will add some 50,000 square feet to existing facilities, and will cost about $750,000.

Bendix Aviation Corp. is adding a new building to the Eclipse-Pioneer Division. The new structure, to be known as Plant 2, adds 103,250 square feet to present facilities, and will be constructed at the Bergen County Industrial Terminal at Teterboro, N. J. to relieve heavy pressure on the Division's main manufacturing plant.

Hiller Helicopters has acquired the rights to the Doman YH-31 helicopter under a license agreement for production by Hiller of the YH-31 military helicopter.

Aeroquip Corporation has purchased the Sterling Electric Motors plant in Van Wert, Ohio, to add to its operating and storage facilities. **Don T. McKone, Jr.** will head the Van Wert plant of Aeroquip as General Manager.

CALENDAR OF AERO EVENTS

Sept. 29-Oct. 3—National Aeronautics Meeting, Aircraft Engineering display and production forum, Society of Automotive Engineers, Hotel Statler, Los Angeles.

Sept. 30-Oct. 2—Aircraft Electric Equipment Conference, American Institute of Electrical Engineers, Benjamin Franklin Hotel, Seattle.

Oct. 1-3—Air Reserve Assn. Annual Convention, Augebilt Hotel, Orlando, Fla.

Oct. 5-9—General meeting of International Air Transport Assn., Montreal.

Oct. 10—England to Christchurch, New Zealand Air Race; speed and transport handicap sections.

Oct. 13-15—Air Transport Assn. Annual Engineering and Maintenance Conference, Saxony Hotel, Miami Beach, Fla.

Oct. 14—P-&-W and Southwest Airmotive engine maintenance and operation forum at SAC, Love Field, Dallas.

Oct. 29-30—NBAA Annual Meeting and Forum. Park-Plaza Hotel, St. Louis, Mo.

Nov. 16-17—Aircraft Quality Control Conference, Biltmore Hotel, Dayton.

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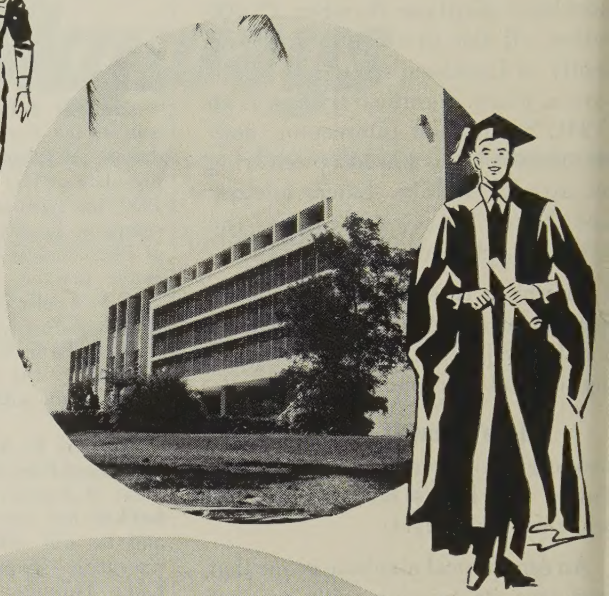

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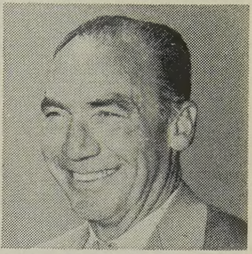
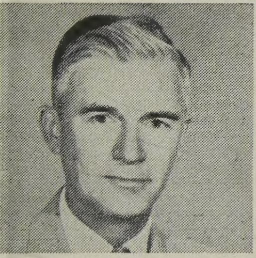
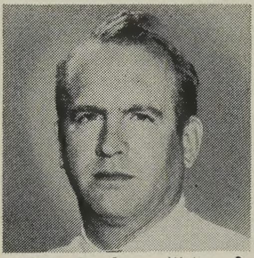
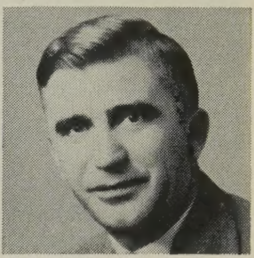

T. E. "Ted" Byron, Aero-Ways, Inc., Municipal Airport, Cleveland, Ohio.


H Warren Holladay, Stonnell and Holladay, Easton Municipal Airport, Easton, Md.


Don Pennington, Carolina Aero Company, Municipal Airport, Asheville, North Carolina.

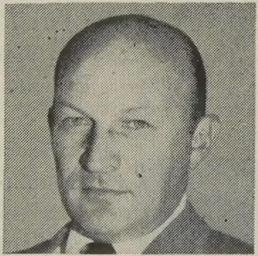

George Harte, Harte Flying Service Municipal Airport, Wichita, Kansas.


Walter R. Crow, Walter R. Crow, Inc., Municipal Airport, Toledo, Ohio.

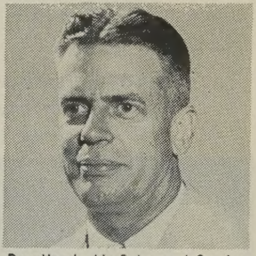

B. G. Vandre, Van's Air Service, Municipal Airport, St. Cloud, Minnesota.


C. W. "Wayne" Crussell, Southern Aero, Inc., Municipal Airport, Atlanta, Georgia.


Cheston M "Chet" Newhall The Babb Co (Canada) Ltd., Montreal Airport, Dorval, P.Q.


Art Meurer, Arthur Meurer Co., Inc., LaGuardia Field, New York, N. Y.


I. H. "Monty" Montgomery, National Aero Sales Corp., Midway Airport, Chicago, Ill.


Don Hood, Air Sales and Service Company, Wier Cook Municipal Airport, Indianapolis, Indiana.


H. William "Bill" Blake, Sales Manager, Washington Aircraft and Transport, Boeing Field, Seattle, Washington.


Fred Smith, Sales Manager, AiResearch Aviation Service Co., 5907 W Imperial Highway, Los Angeles 45, California.


J. K. "Johnny" Hamp, Aero Sales Division, Houston Transportation Co., Municipal Airport, Houston, Texas.


Cy Willock, Sales Manager Downtown Air-Park Inc, 1800 South Western, Oklahoma City, Oklahoma


H. Leibee Wheeler, Buffalo Aeronautical Corporation, Buffalo Municipal Airport, Buffalo, New York.

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The C-124A Simulator

This all-electronic flight simulator represents new advances in transition and proficiency training of air crews

by Herb Fisher
Chief, Aviation Development
Port of N. Y. Authority

The era of the electronic flight simulator is very young, but few advances in aviation have done more in so short a time to promote the fundamental cause of safe, efficient air operations. Its extra, added attraction is its ability to save money.

With more and more airlines turning to simulators to help solve the costly, time-consuming task of pilot and flight crew training and creation of a company to extend simulator benefits to business and airlines pilots, an up-to-date report on these synthetic devices seemed in order.

Accordingly, I spent a day recently flying advanced simulators over in Carlstadt, N. J., home of Curtiss-Wright's Electronics Division, which developed the first electronic flight simulator and delivered it to Pan American Airways in 1948. That pioneering trainer, a B-377, is still in use, having logged more than 20,000 hours and established a remarkable down-time record of only 0.5%.

PILOT *Herb Fisher is at controls of the Douglas C-124A simulator. Cockpit is exact duplicate of Globemaster cockpit*

For the benefit of pilots who may not have had an opportunity to log time on them, electronic simulators reproduce on the ground all of the characteristics of aircraft in flight. They feel like airplanes, act like airplanes, sound like airplanes. And, like airplanes, they can string beads of perspiration on the brow and around the neck. I wore such a necklace while I was learning what it's like to sweat out an ILS approach at the controls of the 175,000-pound Douglas *Globemaster* (C-124A). The fact that it was a simulator, rather than the actual airplane, made little difference. I'd say it's tougher in the simulator because all landings in these synthetic crew trainers are completely blind. I flew the B-377 simulator and found it to be amazingly realistic. The C-124A simulator, newest in a long line of synthetic crew trainers masterminded by Dr. Richard C. Dehmel, incorporates all advances in this new art since the B-377 was produced.

With the C-124A, Curtiss introduced for the first time such new features as completely electronic control loadings for fast, realistic aircraft responses; precise cockpit duplication with every control, instrument and switch activated electronically; improved accessibility to all components; and a completely self-contained power supply to assure the right sequence of "power on" procedures.

Mechanical control loadings are eliminated in the C-124A, providing greater precision in cockpit duplication, and the simulator therefore makes possible maximum flight crew training for any mission normally flown by that aircraft. Pilot, co-pilot, engineer and check pilot can work together as a team,

INSTRUCTOR'S COMPARTMENT *of the simulator features trouble console (left), radio aids panel (next to it) and three flight recording charts. Round chart shows where pilot has been flying during approach; overhead chart shows glide path*

and a radio operator and navigator can be added when necessary.

Progress in fabricating techniques enables the user to hold maintenance and repair times to a minimum. Ease of maintenance is reflected in lower down-time averages. For example, down-time on earlier C-W Dehmel simulators has averaged 2% or less, even when they were operated 18 hours a day. On one unit, the C-97A, down-time was only 60 minutes during the first 1,046 hours of operation. That's less than half of one percent. The same low down-time average is expected with the C-124A, which is now being used by military pilots at Morrison AFB, West Palm Beach, Fla.

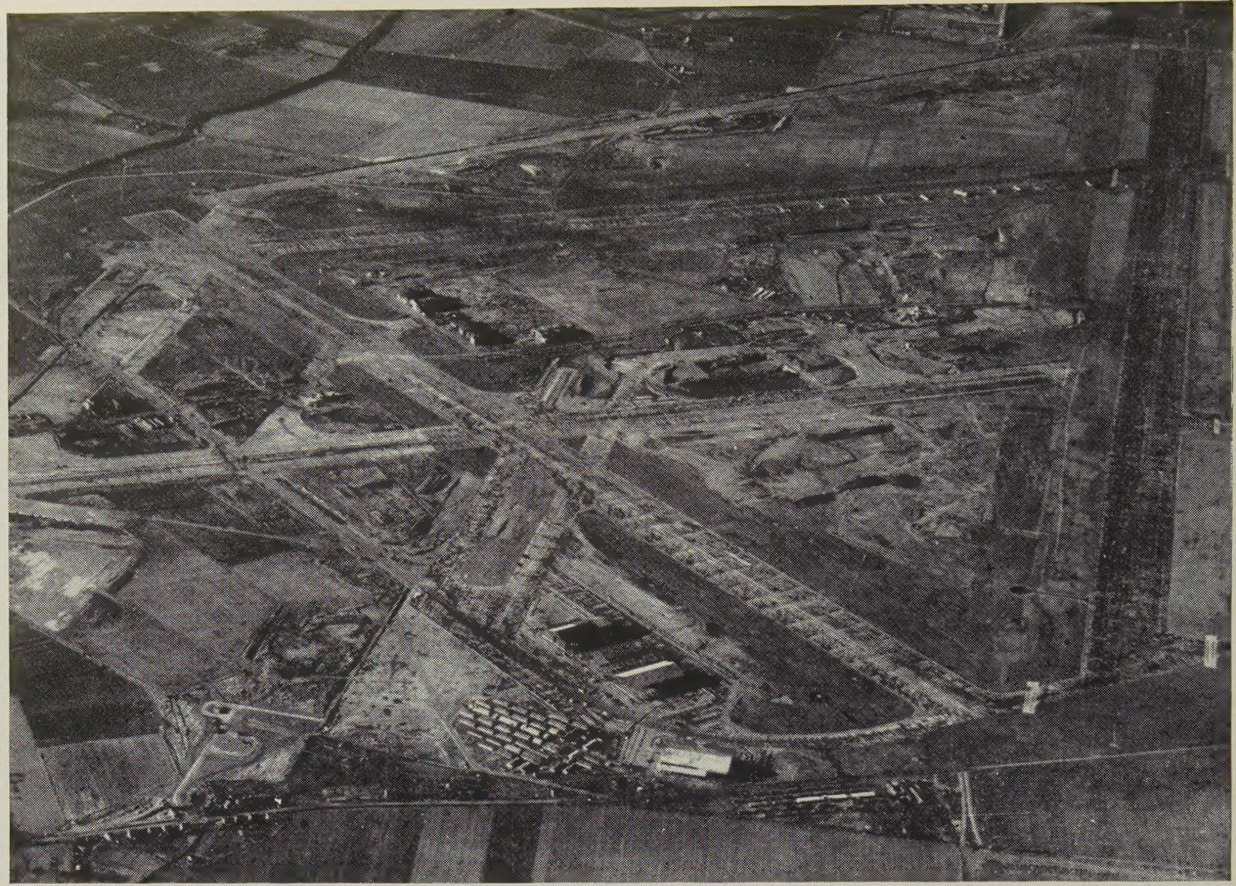
The C-124A simulator is highly sensitive to small displacements of flight controls and Curtiss believes its electronic control loadings provide a degree of simulation never before achieved. From the standpoint of the pilot, I can report that damping effects, control surface inertia, control boost failures and aileron and rudder responses are highly accurate in feel.

Like its predecessors, the C-124A simulator is equipped with the C-W automatic radio aids unit. It is a universal type and it permits simulation of high and low frequency stations in any desired combination. It therefore permits simulation of navigation facilities for any area in the world. All maneuvers executed by the aircraft are charted on course approach and altitude recorders, enabling the instructor and pilot trainee to review details of each flight.

The C-124A unit includes low frequency AN range stations, DME, ILS, and GCA instrument landing systems with movable markers and adjustable glide slope angle; offset course computer, and universal station identification keyers.

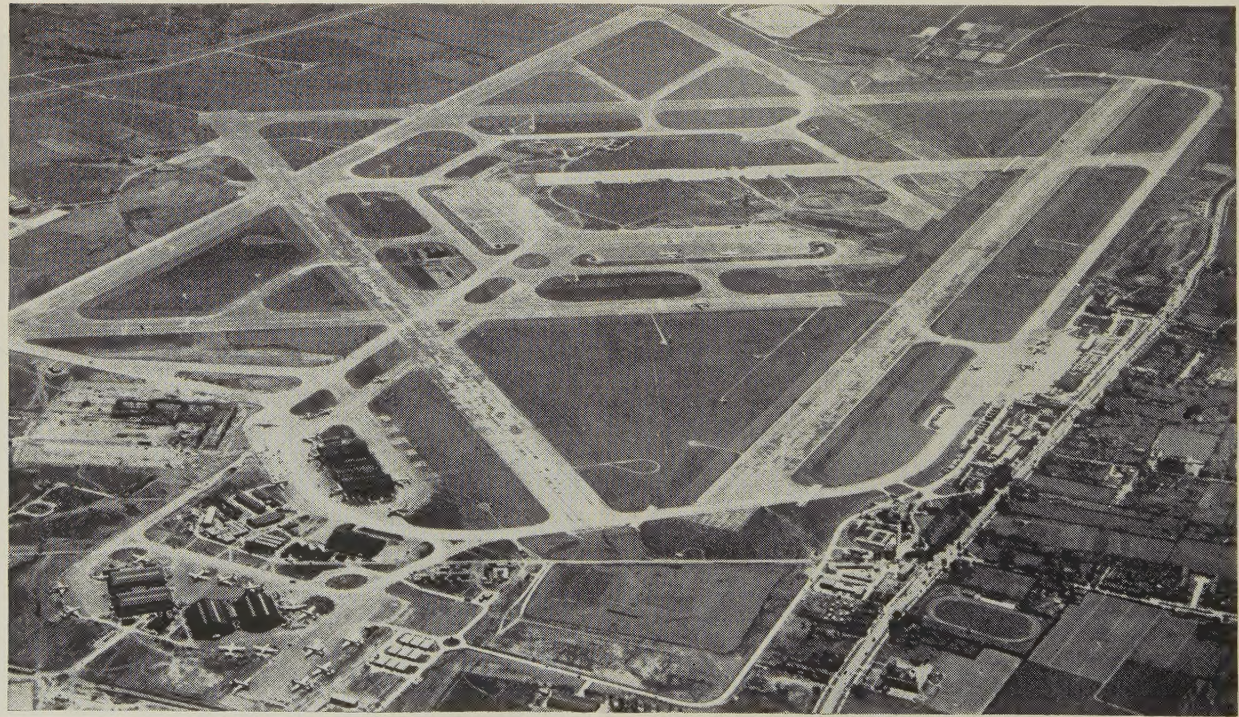
The trouble console, and I mean *trouble*, enables the instructor to add emergencies to any flight routine at will. He can inject instrument and landing gear failures, fires, propeller and engine trouble, wing and carburetor icing, and inadvertent prop reversals, to name a nasty few. He can even reproduce emergency situations far too dangerous to try in actual flight.

In short, the Curtiss-Wright C-124A represents the latest refinements in the art of electronic aircraft simulation. *(Continued on page 48)*



LONDON AIRPORT *(Fig. 1) looked like this (above) in 1946 when photo was taken looking to the west. Runway 28R runs almost parallel to the right-hand edge of the picture. The other open runway, 23L, slants off to the left from the bottom of the photo. In the right-hand background, aircraft are parked out in open on Runway 15R, not in use in '46*

TODAY, *London Airport looks substantially like this (Fig. 2, below). Photo was made from much the same angle as '46 one. Runways displayed are 10L-28R, 10R-28L, 15R-33L, 15L-33R, 23L-05R, and 23R-05L. Runways are concrete and smooth, with no settling evident to date; all are level with maximum difference in height of runway ends only four feet*



Pilot's Preference

THE LONDON AIRPORT

Experienced international airline pilots call London Airport "finest and safest." Here are reasons why

by William W. Moss

Capt., Pan American World Airways

Idlewild is bigger, Zurich is newer, Washington handles IFR approaches faster, and many other fields are busier, but, in the opinion of experienced international airline pilots, London Airport is the finest in the world. To an airline pilot finest is synonymous with safest so this discussion will be devoted to those features of the airport which contribute to its safe operation and will leave the passenger-handling facilities alone, other than to remark that they are adequate if not flashy.

Originally conceived during World War II as an RAF transport airport but with the secondary purpose of becoming the main international civil airport for England in peacetime, London Airport, or Heathrow as it was originally called, was turned over to the Ministry of Civil Aviation in mid-1945 before any of the three runways then planned were completed. Actual scheduled operations were inaugurated January 1, 1946 when British South American Airways Corporation commenced their Mid- and South-Atlantic flights. In May of that year, American Overseas Airline and Pan American Airways moved their operations to London Airport from Hurn, at Bournemouth some 70 miles to the South of London, and were followed two months later by British Overseas Airways Corporation. At this time only two runways were in service, 10L - 28R and 05R - 23L, and passenger handling dispatch, meteorological services, etc., were conducted in tents and trailers amid a sea of mud, but the field was operational at a time when Idlewild was in a state of more advanced completion but whose opening was completely bogged down in New York politics and labor disputes. During this period an Advisory Lay-Out Panel was considering the future development of the field, and it is to that Panel and its staff that credit must be given for the London Airport's present high standard, bearing in mind, of course, that they had an initially sound location to develop, one with unobstructed approaches and with excellent subsoil both as to drainage and as to load bearing characteristics.

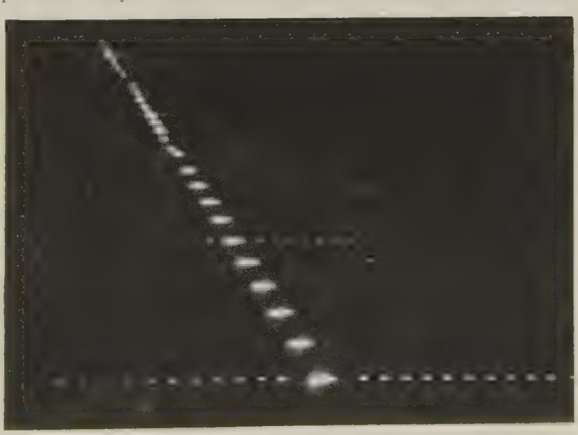
Figure 1 is a photograph of the field taken late in 1946 looking to the West. Runway 28R runs almost parallel to the right hand edge of the picture, while the perimeter taxi strip runs down the edge and the temporary tents and trailers are just out of sight. The other open runway, 23L, slants off to the left and in the background aircraft are parked out in the open on Runway 15R which was not in use at that time. In contrast to this early photo is Figure 2 which shows the airport pretty much as it is now. Figure 2 was taken from much the same angle as was Figure 1. The magnificent runways displayed here are:

10L - 28R	9570′ by 300′
10R - 28L	9570′ by 300′
15R - 33L	7735′ by 300′
15L - 33R	6000′ by 200′
23L - 05R	7735′ by 300′
23R - 05L	6500′ by 200′

These are all of concrete, smooth with no settling evident to date, and are substantially level, there being a maximum difference in height of runway ends of only four feet.

In addition to this layout, there was originally planned a triangle of runways to the North of the present terminal area. However, this plan was modified in the light of experience after 1946 to call for only two divergent runways and now, in the light of still further experience *(Continued on page 47)*

APPROACH LIGHTS *(Fig. 3) to runway 10R look like this to pilot in cockpit. Center line extends 3,000 feet from threshold*



1927—*Cockpit and panel of the Boeing 40-A mail plane*

The Complexity

Emphasis must be placed on achieving reliability rather than simplicity

During the past year, the increased complexity of aircraft has been the subject of a great deal of discussion. There is no question that simplification is desirable; in attempting to achieve it, however, a differentiation must be made between needless or harmful complexity and that complexity which serves an essential purpose.

Complexity in and of itself is not necessarily an evil. Our entire civilization and mode of living is based on mechanical complexity. An automatic washing machine is much more complex than a washboard and tubs; modern telephone and telegraph systems require more complex equipment than did the pony express. In these cases, and in countless others, mechanical equipment which is extremely complex has made the process of living less complicated. Similarly, extremely complex mechanical equipment in an airplane may make the operation of that airplane less complicated. The real question, then, is not whether the modern airplane is complex, but whether it is unnecessarily so, and as a result loses in utility, reliability and safety.

The equipment needed for instrument flying and long-range navigation is mechanically complex, yet has increased the safety of flying and has also extended the usefulness of the airplane. Similarly, the equipment necessary for ILS approach has added mechanical complexity, yet how many pilots would be willing to remove this equipment and go back to making circling approaches under an overcast? How many would go back to flying a DC-3 over the Rocky Mountains, as compared to flying a pressure-cabin airplane; yet cabin pressurization adds to the complexity of the airplane.

Each such increase in complexity, which in turn has extended the utility and increased the safety and the comfort of the modern airplane, has involved the installation of additional instruments and controls, making the pilot's problem more complex. At the same time, the increase in the speed of aircraft has, in many circumstances, reduced the amount of time available to the pilot to perform any given function.

Complexity and the Pilot's Task

The airplane is one part of a man-machine combination. Therefore, the important question is not whether the machine is complex in itself, but whether the man-machine combination can function efficiently. We have not gained in over-all simplicity if, by extreme simplification of the machine, we complicate the situation for the human operator to such a point that we approach or exceed his basic limitations. It is often necessary to complicate the machine to simplify the pilot's task. When a pilot must go through a complicated sequence of control manipulations to perform a comparatively simple function, it will usually be found that the mechanics of the system is too simple; that had the system itself been made more complicated its operation by a single control might have been possible.

Simplification through Complexity

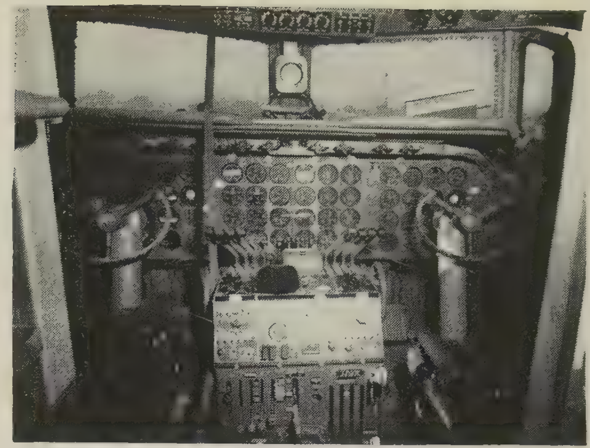
An illustration can be found in the emergency landing gear extension system of early F-84 airplanes, and in almost identical systems which were installed in other fighter aircraft. The main landing gear, in this case, will drop by gravity. Because of space limitations, the nose gear retracts aft, and drag prevents its dropping to locked position. Since a hand pump was needed for ground servicing of the hydraulic system and for operating other units in an emergency, the simplest way of providing for emergency extension of the nose gear was to use this pump, drawing from the emergency hydraulic supply. To reduce the amount of pumping required, a selector valve was added to isolate the nose-gear system from the rest of the hydraulic system.

To achieve emergency extension of the landing gear with this system, it was necessary for the pilot to place the landing gear selector handle in "Down" position, and then pull the emergency "Up-

# of Simplification

by William I. Stieglitz

Design Safety Engineer, Republic Aviation Corporation



1953—*Cockpit and panel of today's Douglas DC-6 transport*

Lock" release. Following this, the selector valve was placed in "Nose Wheel" position, and the pilot pumped the nose gear down. After this was accomplished, if the pilot wanted to lower the flaps, the selector valve had to be returned to its normal position, the landing gear handle returned to neutral, the flap handle placed down, and the hand pump used to extend the flaps. It might be pointed out that nose-gear extension took eight to 10 strokes of the pump. Another manufacturer further simplified a similar system by eliminating the hydraulic selector valve. The result of this simplification was that 10 times as many strokes of the pump were required to lock the nose gear down.

It is rather obvious that the procedure described above was time-consuming. As a result, pilots experiencing engine failure at low altitude often did not have time to get the nose gear locked down before touch-down, and the gear collapsed on landing. On the other hand pilots who had sufficient altitude tended to extend the gear early. With a dead engine, the resulting additional drag of the gear often caused the pilot to undershoot. Besides these two conditions, an error was frequently made in one step or another of the complicated sequence of operations.

This situation was corrected by complicating the airplane. An emergency pneumatic system was installed in such a manner that pulling the emergency gear handle operated the necessary valves and discharged a high-pressure air bottle into the nose-gear extension cylinder. In the later aircraft incorporating this system, the pilot need only place the landing gear selector handle in down position and pull the emergency up-lock release. All three elements of the gear extend and lock in a matter of seconds. It is true that, in incorporating this pneumatic system, complexity and weight were added to the airplane; the system was made more complex, yet the net over-all result was greater simplicity.

The dimming of cockpit warning lights affords a further example of mechanical simplicity which produced control complexity and loss of safety. The need for dimming such lights is obvious, since lights which are bright enough to be seen in the daytime are too bright at night. The standard method of providing control, up to the present time, has been by means of individual hoods on the lights. There have been many instances of pilots failing to make sure that all warning lights were full bright prior to take-off in the daytime. Accidents have resulted because the pilot subsequently failed to see a dimmed warning light.

Accidents of this kind will be prevented by the added complication of a master dimming switch, such as has recently been adopted as standard by the Armed Forces. With this system, all warning lights are full bright when the cockpit lights are off, and are dimmed automatically to the proper level for night flying when the cockpit lights are turned on. An override switch is provided which permits the pilot to turn the warning lights back to bright, when he is using cockpit lights in the daytime to relieve sky glare. The override switch is automatically reset when the cockpit light switch is turned off. The complexities of such a system are apparent; so also are the increased safety and the control simplification.

Automatic Systems

Automatic systems represent even greater complexity aimed at simplifying the pilot's task. Many pilots object to automatic controls because of experience with systems which were subject to malfunction and left them without adequate control or without sufficient warning to permit them to assume control. Criticism of such systems is thoroughly justified. Nevertheless, in many cases the answer is not to be found in throwing out automatic control systems, and thus imposing an excessive burden on the human operator. Instead, the automatic system should *(Continued on page 50)*

THE AIR TRAFFIC STORY

No.3: Elements of the Common System

DME, Course Line Computer, Airborne and Ground Radar give impetus to the accomplishment of true all weather flight

A motorist "navigating" along a highway has a number of advantages over the pilot flying along an airway during instrument weather.

The motorist, for example, has an accurate speedometer which tells him how fast he is progressing over the earth's surface. And he has a mileage indicator to tell him how far he has progressed.

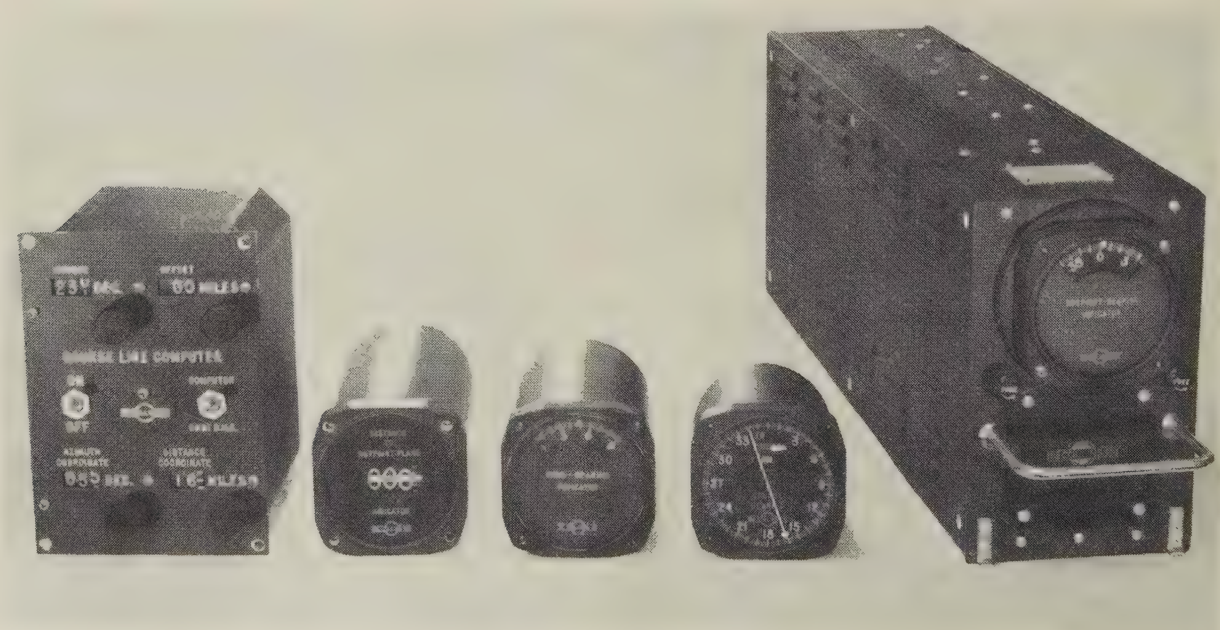
Until recently, no such information has been available to the pilot. He has an airspeed indicator which tells him how fast he is moving in relation to the air around him. Unfortunately, this has little relation to his progress over the earth's surface because of constantly changing wind conditions as the flight progresses. The airspeed indicator is a necessary and helpful instrument but rather vague about what the pilot needs most to know—his progress in relation to the ground. An extreme example can be demonstrated in a small aircraft flown against a high wind. The airplane can stand still in relation to the ground, or even drift backward, while the airspeed indicator registers 50 or 60 mph.

Distance Measuring Equipment

Very recently, an electronic speedometer has been developed for the pilot under Common System sponsorship. It tells his speed in relation to the ground and, like the mileage indicator in an automobile, it tells him the distance to or from a point on the ground—usually a VOR. This new equipment is called Distance Measuring Equipment—or DME. Combined with the VOR for bearing information, this adds up to continuously accurate navigation, either on or off an airway.

What the pilot sees in the cockpit is similar to the speedometer and mileage indications in an automo-

COURSE LINE COMPUTER *equipment (below) was developed by Collins Radio under sponsorship of Air Navigation Development Board to specifications established by TDEC. Photo shows computer's control head, the instruments and amplifier*



bile. But behind this simple presentation is an intricate collection of electronic equipment in the aircraft and on the ground.

DME operates at about 1.000 mc in the ultra high frequency band. It requires a receiver-transmitter combination in the aircraft, and another on the ground, usually at a VOR site. The airborne equipment is called an "Interrogator", the ground equipment, a "Transponder."

The interrogator in the aircraft sends out a pair of radio pulses which are received by the ground transponder. The transponder replies with another pair of pulses. These are received in the aircraft, where the elapsed time between the transmission and the return signal is measured electronically. The elapsed time, translated into miles, is presented to the pilot by his cockpit instrument. It may also be presented as miles per hour toward or away from the ground transponder.

The measurements involved in DME include such tiny increments of time that the human mind can scarcely conceive of them. Radio waves travel at the speed of light—about 186,000 miles per second. A radio pulse could travel around the earth at the equator more than seven times in a single second. Yet DME measures the time required for the radio pulses to travel a few miles and even fractions of miles—measurements in millionths of a second, made many times a second.

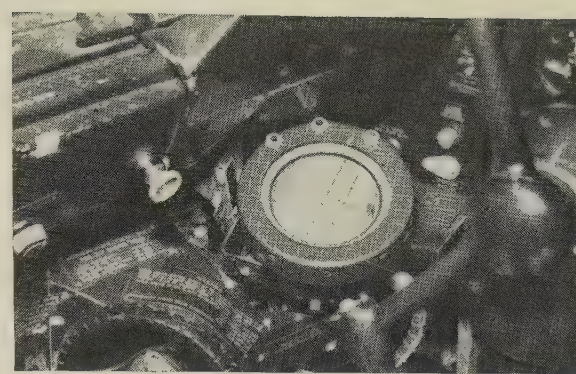
A spaced coding of the pulses is necessary to be certain that the "query" from the aircraft is answered by the correct ground transponder originally "queried". A single ground transponder can handle simultaneous "queries" from approximately 100 aircraft.

Course Line Computers

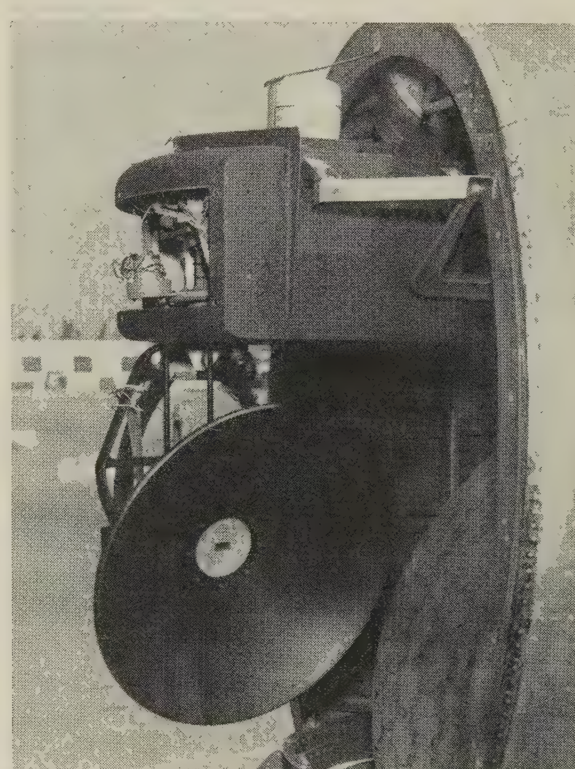
The VOR, plus DME, is the basic enroute navigational aid of the Transition Phase of the Common System. Together, they provide all navigational information necessary to fly along an airway to or from a VHF Omnirange. The two aids continuously pin-point the position of the aircraft. In the form described earlier, however, they fail to provide an easy way to fly a straight course which passes to one side of a VOR instead of directly over it.

A device called the Course Line Computer makes it easy to fly a straight line from anywhere to anywhere within reception range of a VOR/DME station. It also makes possible parallel flights at the same altitude along an airway with safe lateral separation.

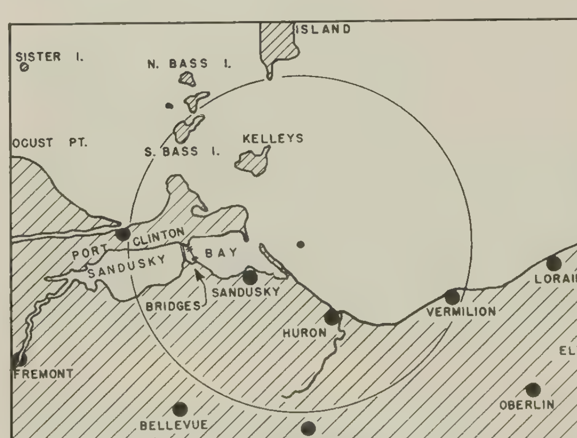
The Course Line Computer continuously analyzes navigational information available in the cockpit, including that received from the VOR and DME. By electronic means, it continuously solves complex navigational problems and presents the solution to the pilot in the form of a course to fly on the right-



AIRBORNE RADAR *scope installation shown here (above) is on an American Airlines Convair. Most promising use of airborne radar is in avoidance of heavy storm areas. Radar antenna reflector (below) is installed in the nose*

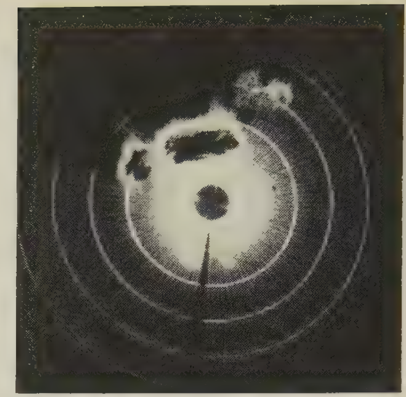


MAP *shows the Lake Erie area scanned by a radar installed aboard an aircraft. Water areas show up dark on scope*



AIRBORNE RADAR *display (left) of several thunderstorm cells is with conventional radar. The heavy rain areas appear as bright spots on the radarscope in the aircraft cockpit*

SPECIAL CIRCUITS *in airborne radar receiver results in two-tone display (right) which allows pilot to select flight path that avoids the most turbulent areas of the storm*



left needle of his VOR Receiver Deviation Indicator.

In effect, the Course Line Computer moves the VOR and the DME transponder to whatever point the pilot selects. A pilot, for example, wishes to fly to Podunk from Grasshopper. Neither town is near a VOR/DME station. The pilot sets certain navigational information into the computer, tunes in any available VOR/DME, and takes off. He "flies the needle" as in normal VHF Omnirange flying. By the magic of computer electronics, the VOR/DME station has now been "moved" to Podunk for his personal convenience.

Pictorial Displays

One way of presenting navigational information to the pilot is to show him his position continuously on a map or chart. A number of devices of this kind are under development.

These Pictorial Displays are made possible by electronic computers which, like the Course Line Computer, continuously work out navigational problems. Instead of presenting the results in left-right needle indications, however, Pictorial Computers show the plane's position as a moving spot on a map in the cockpit. The basic information is derived from VOR and DME signals.

Some of these Pictorial Displays trace a line on a chart as the aircraft progresses. Others use a spot of light. Some use actual charts. In others, the chart is projected from movie-type film. The form which eventually will be most practicable has not been determined.

Pictorial Displays provide a pilot with what is probably the simplest and clearest means of knowing where he is at a given time. They make it easy for him to fly any desired course. By simply drawing his course line on the map or chart, the pilot can "fly to the line" in the same manner that he "flies to the needle" in VOR and ILS operation. Those which trace lines on a chart also tell him clearly where he has been.

There are, however, some disadvantages in Pictorial Displays, at least in their present form. They tend to be bulky, often require large numbers of special charts, and sometimes involve a variety of gears to handle various chart scales. These drawbacks eventually may be eliminated by improved design techniques.

Air-Ground Communications

VHF Omniranges, supplemented by DME, supply the pilot with all the enroute navigational information he needs. But he needs something else for safe, efficient flight. He needs traffic control instructions from the communications stations and traffic control centers along his route, plus information about weather conditions ahead. This calls for communication with the ground.

Two-way radio communication is the obvious means of communication, and voice transmissions have proved much more useful than Morse code signals for most aviation purposes. Until World War II, air-ground voice radio communication was on relatively low frequencies—just below and somewhat above the standard radio broadcast band.

Low and medium frequency communications, like LF/MF Four Course Radio Ranges, were plagued by static from time to time. Also, the number of channels was severly limited and, as radio traffic increased, the interference became almost intolerable.

Shortly before World War II, research was extended higher into the radio-frequency spectrum, and the advantages of Very High Frequencies (30 to 300 mc) became apparent. These frequencies were static free; hundreds of new channels were available; and their line-of-sight transmission characteristics prevented long-distance interference between stations on the same frequency. Military aviation communications moved quickly into the very high frequencies, and civil aviation followed on the heels of the military. There are signs that this upward frequency trend may continue, since some military communications are now operated on frequencies above 200 mc. Today, however, most communications between air- *(Continued on page 54)*

Business Pilot vs. Airline Pilot

by Jean H. DuBuque
Executive Director, NBAA

An analysis and comparison of duties and responsibilities of the business-aircraft pilot and the airline pilot indicates that in many respects the job of the business pilot is far more exacting

Often today NBAA members are asked, "What is the difference between a business pilot and a scheduled airline pilot?" To answer this question practically, a careful study was made of the duties and responsibilities of both types of pilots. It was found that, although flight activities were basically similar, it was there the comparison ended.

In many respects, the job of the business pilot is far more exacting than his airline contemporary. He must be prepared to fly anywhere at anytime, frequently over unfamiliar air routes and into airports with inadequate air navigation facilities. He usually serves as his own dispatcher, navigator, meteorologist, steward, and occasionally as his own mechanic. He generally has no large ground organization upon which he can rely for service. He must have the confidence and courage to resist any pressure, direct or implied, to compromise safety for convenience. His character and moral standards must be of the highest order, since he pilots top business executives who are among the most successful throughout the nation.

In no way does the previous summary of the business pilots' general duties, his responsibilities and qualifications reflect unfavorably on the character, skill and experience of the airline pilot. Both are professional men engaged in important parallel activities—transporting people by air to predetermined destinations at prearranged times in well-equipped aircraft. Where does the difference lie? The following analysis specifically compares the flight activities of the two pilots for the first time, spelling out step-by-step and in great detail the differences and similarities and the manner in which each must qualify to shoulder the duties and responsibilities of an important job *(Continued on page 53)*

BUSINESS-AIRCRAFT PILOT *is responsible for readiness of his company plane. He must check on all services to aircraft; be a dispatcher, luggage man as well as a safe, efficient pilot*

AIRLINE PILOT *must be equally safe and efficient as business pilot, but airline has own service and maintenance departments and a dispatcher who provides the weather information*

FRANK C. WHITE, with the ANTC Division of ATA three years, has spent 15 years in airlines communications, navigation and traffic control, plus three years in U.S. Navy air operations.

Accuracy and Utility of the VOR System

Experts in navigation and communications evaluate the accuracy, operational utility and future growth of VHF omnirange

FLIGHT OPERATIONS *Round Table on accuracy and utility of VOR system was attended by (clockwise around table, beginning lower left) K. R. Evans of Mohawk Airlines; H. W. Fraley, CAA; Capt. Harrington, Eastern Air Lines; William Person, Flight Safety Inc.; Donald Stuart, CAA; Cole Morrow, NBAA; Capt. Arthur Jenks, CAA; Owen F. Thomas, CAA; Capt. S. C. Hoyt, United Air Lines; Capt. E. J. Smith, United Air Lines; Earl Blanchard, an observer; George Litchford, Airborne Instruments Laboratory; Frank White, ANTC Division of ATA; Tom Neyland, Albert Trostel & Sons Co.; Dave Peterson, Sinclair Refining; R. Clyde Wheeler of AIL. Capt. J. D. Smith arrived after photo was taken*

Moderator Frank C. White *(ANTC Div., ATC):* "New systems, particularly new navigational systems, for use by aircraft in flight are seldom implemented as rapidly as desired. Two good examples of this are the Instrument Landing System (ILS) and the High Intensity Approach Light program. The ILS program is now in the final stages of completion but the Approach Light system, which would seem to be a straightforward system, has been traveling along as many devious paths as a ping pong ball. Although the VOR program is by no means nearing completion, with 369 stations commissioned thus far, it is becoming a very useful and essential part of the Federal Airways system.

"In line with this, I'd like to make a prediction regarding airlines use of VOR and Victor Airways. To date, about 1% of airline IFR flight is based on clearances filed for Victor Airways. By next spring, more than half of all airlines flights will be predicated on Victor clearances. In other words, we are today on the threshold of making extensive use of the VOR and Victor Airways systems for IFR flight.

"VOR, however, does have its share of problems. The VOR ground station is very difficult to site. The CAA wants to provide and, in fact, the users demand accurate navigational information for 360 degrees around the station. As a result, the CAA

has to find VOR sites that are about as flat as a pool table and at least 2,000 feet in diameter. There are few such optimum sites in mountainous country. Also, there are few optimum VOR sites in congested terminal areas.

"The system, both airborne and ground equipment, is decidedly more complicated than the L/MF radio range that it eventually will replace. We seldom get something for nothing and that's true of the VOR. The VOR receiver is several times as complicated as the LF receiver, and the same is true in a direct comparison of the complete VOR ground station installation and the four-course range.

"In this matter of VOR system accuracy, let's have the pilots here tell us about some of their day-to-day experience using VOR."

Capt. E. J. Smith *(United Air Lines):* "About eight months ago a few of the pilots were given sheets to fill out on each trip to determine accuracy of the different VOR stations. At that time I was flying LaGuardia-Chicago airway, and over a period of about a month there was only one station where I found a deviation of more than 3 degrees. That was on the Goshen VOR site. Since that time, I believe, that site has been changed. On all other stations, the readings were well within 3 degrees."

Frank C. White: *"The series of tests you mention, Capt. Smith, was continued by ATA for the scheduled airlines in conjunction with a survey desired by RTCA. We ended up by getting about 6500 checks of the omnirange. In making the test, the pilot checked accurately over some fix—an omnirange, a four-course range or an H-facility. Then with some VOR station about 100 miles away, he would rotate his OBS until the FPDI had centered. The omni bearings were then recorded on the sheets that Capt. Smith mentioned. All these sheets were sent to our office and we made a tabulation of the results. Of more than 6,000 results sent in, two-thirds of the observed bearings were better than plus or minus 2°. Airborne Instruments Lab also made a survey. George Litchford, will you tell us something about that survey?"*

George Litchford *(Assist. Supv. Navigation Section, Airborne Instruments Lab):* "About three years ago we had a contract with ANDB to go out and measure the VOR system as accurately as we could. To be realistic about what we were measuring, three VOR stations were selected—Patuxent Naval Air Station, which is a flat location; Phillipsburg, on top of a mountain; and Ogden, Utah, a valley station. The standard of measurement used was the Shoran system which is a multiple site, pulse time-difference system that, when suitably installed, provides a measurement accuracy of two-tenths of a

OCTOBER 1953 — SKYWAYS FLIGHT OPERATIONS ROUND TABLE — *Wings Club New York, N. Y.*

Round Table Participants

EDWARD F. HARRINGTON soloed at 14, owned a plane at 15. He operated a flying service and was a mapping pilot before joining EAL in 1938.

ARTHUR E. JENKS was named Chief, Flight Inspection Div., CAA in 1950. Capt. Jenks has had an ATR since 1932; joined CAA as Insp. in 1940.

COLE H. MORROW, Chairman of Board of National Business Aircraft Assn., is Chief Plant Engineer, J. I. Case Co. He is member of RTCA.

DONALD M. STUART has been Director of CAA's TDEC since 1943. He began his career with CAA as a radio engineer in 1934; became Chief in '39.

S. C. HOYT, Flight Manager, United Air Lines, at LaGuardia, joined United in 1937; was in USAF-TCC during war.

GEORGE LITCHFORD, Assistant Supervisor, Navigation Section of Airborne Instruments Laboratory, has been actively engaged in research since '41.

KENNETH R. EVANS, Supervisor of Communications for Mohawk Airlines, joined that organization in 1947 when it was known as Robinson Airlines.

WM. P. PERSON, former manager of Air Transport Div., Flight Safety Foundation and American Airlines' captain, is now with Flight Safety Inc.

J. D. SMITH, Regional Safety Chairman of Air Line Pilots Association and a Capital Airlines' captain, began his flying in 1938; joined Capital in '45.

TOM R. NEYLAND, Chief Pilot for Albert Trostel & Sons Co., has been with that organization since 1946.

R. CLYDE WHEELER, also of Airborne Instruments Laboratory, was in charge of data analysis of ANDB project for evaluating the VOR system.

DAVID G. PETERSON joined Sinclair Refining Co. in 1944 and now is Chief Pilot. During the war, he was with Boeing at Wichita and with Beechcraft.

OWEN F. THOMAS, Flight Operations Specialist, CAA, was with United Air Lines as First Officer from '45 to '48. Mr. Thomas joined CAA in '48.

HARLAN W. FRALEY is an Airways Operations Specialist, New York Regional Office, CAA. He began his career with CAA in 1940 in ARTC.

CAPT. E. J. SMITH has been with United Air Lines since 1934 and has logged 16,000 hours; is U. of Ala. grad.

degree or better. Knowing that we were measuring a device that had errors on the order of 2 or 3 degrees, we had a yardstick that was about an order of magnitude better.

"The measurements were made mainly by flying radials and orbits with respect to the omnirange stations. The orbits were at different altitudes and different ranges so that we could get a complete picture of what the space pattern and the accuracies at different elevation angles and ranges to the omni were like. To gather this data, some 300 hours of flight time were spent, as well as a lot of manpower, to boil down the data and come up with some error curves.

"In general, we found that we could break down the errors into categories. The ground station has errors that are attributed to the transmitter, antennas, goniometer and the like. Another error we called 'site effect.' These were errors caused by objects such as trees and powerlines in the immediate vicinity of the station. Another was 'terrain effect' error; when flying near a mountain, for example, you get some small reflections back, and this creates errors in some locations. There was attitude error due to aircraft pitch, heading or roll. The attitude error is traceable to the polarization effect created by radiation from such items as the vertical mounts for the horizontally polarized VOR antennas. Then, of course, there is receiver error due to the fact that the receiver is not a perfectly linear phase measuring device.

"We published a report on this, giving a sort of rule of thumb as to the amount of error that can be attributed to each of these five categories. Several of them are readily monitored one way or another. For example, your receiver error can be monitored very readily with dual installations. Ground station error is monitored by CAA equipment.

"It appears that the AIL measurements were in close agreement with the ATA data, that is, most of the measurements are within plus or minus 2° to 3°, with a few excursions to as great as 4° or 5°."

Frank C. White: *"A number of aircraft are equipped with dual installations of VOR receivers, so let's have the pilots' comment on how well two VOR receivers in the same aircraft agree with each other when receiving the same VOR station. Captain Hoyt, you fly Convairs for United Air Lines that are dual equipped with Collins receivers. What can you tell us?"*

Capt. S. C. Hoyt *(Flight Mgr., United Air Lines):* "Normally, I find one piece of VOR equipment runs more or less parallel with the other. In our airplanes, we have VOR instrumentation on the First Officer's side and on the Captain's side. If you keep them on the same VOR radial, you can check them very closely, within a degree or even half a degree. Capt. Smith has flown the line more than I have recently."

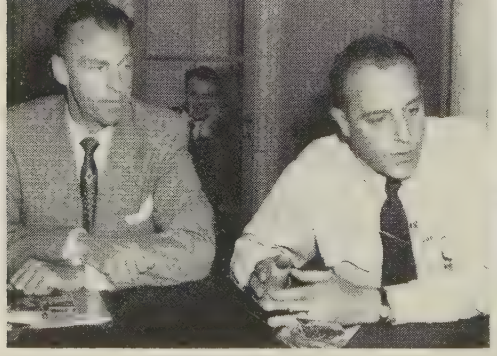
Capt. E. J. Smith: "I can't add much to that, except that in testing our VOR system on the ground in Chicago and also here at LaGuardia on the test frequency of 112, we're allowed a 2½° tolerance. It has been a long time since I've had to note in the log book that the readings at Chicago and New York were as large as 2½°. They're always under that."

Frank C. White: *"Capt. Harrington, would you like to add your comments?"*

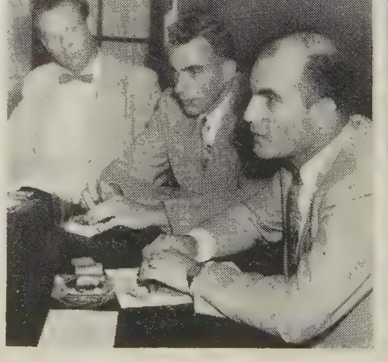
Capt. Edw. F. Harrington *(Check Capt., Eastern Air Lines):* "We have a dual VOR receiver installed in Eastern Air Lines aircraft but we have a selector so that the captain's flight path deviation indicator can read from either the #1 or the #2 receiver. It's been my experience that both receivers check out pretty accurately."

Frank C. White: *"You use the single flight-path deviation indicator and you can select either receiver after you've set the OBS? You switch the OBS and the FPDI at the same time, isn't that the way it's done?"*

Capt. Harrington: "That's right."



"PILOT *starting down from 21,000 feet could over-run allocated holding area," reported J. D. Smith (right, next to Capt. E. J. Smith)*



"EFFICIENCY *is reduced," said Mr. Fraley (right), "when ATC has to handle both VOR and LF flights"*

"VOR *measurements," reported Mr. Litchford, "showed most to be within plus or minus 2° or 3°"*

Frank C. White: *"What about the business pilots? Do any of you have any comments regarding the accuracy of the omni as observed in flight?"*

Business Aircraft

David G. Peterson *(Chief Pilot, Sinclair Refining Co.):* "We have the dual installation in all of our multi-engine all-weather aircraft. We don't have Collins equipment in every case, but we do have either ARC or NARCO, and in some of the ships we have the selector Capt. Harrington mentioned. We've found very little error, 2° or 3° is as high as we've ever seen."

Cole H. Morrow *(Chief Plant Engr., J. I. Case Co., Chm. Board, NBAA):* "Over a period of the last three years we've been running an unofficial check as to accuracy, and we have found that in using sectional charts as a guide, the accuracy of the VOR is about on the order of the accuracy of the pilot to determine position visually, and the accuracy of the charts themselves. We've found that there are a great many errors in the charts that, at first, we thought were inaccuracies in the VOR. We feel that VOR is as accurate as you can fly the airplane."

Frank C. White: *"That ought to be encouraging news for Art Jenks. He's responsible for the flight checking prior to commissioning of the omni."*

Arthur E. Jenks *(Chief, Flight Inspection Div., CAA):* "In some of our calculations we use a measurement of coverage which is called a degree/mile . . . one degree of azimuth and one mile of distance. Out to 60 miles on a low freq. range you have 720 degree miles on the four-courses. With the VOR system where the range is 50 miles at the lowest altitude, you have 18,000 degree miles. You can estimate coverage in degree miles and run it all the way up to jet altitudes . . . and you come up with an astronomical figure. So you can see what a problem we have in proving the accuracy of a facility of that type throughout its entire service area.

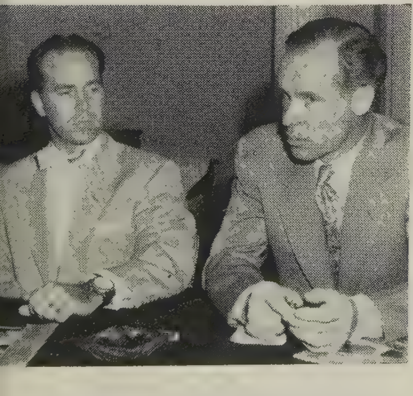
"The AIL project was an engineering one. On the other hand, we have had to condense our project to a production-line basis. All we can do is verify all of the courses at sampling points at various distances. It took AIL 300 hours on three stations and a corps of engineers to resolve the data. We spend about 18 hours on each station and three men do all the work. When we have finished, we have sampled it at seven different places in all azimuths and measured the close-in characteristics very carefully. From that we get a pretty good composite picture of both the course accuracy and the radiation pattern from the station. In the matter of accuracy, we don't okay anything that's over the prescribed tolerance of 3½° plus or minus. We're finding a majority of our stations are running far under that in the initial close-in circle. It's been something on the order of 2.2°."

Frank C. White: *"That's measured at one mile?"*

Arthur E. Jenks: "That's measured at five miles. Our problem there is to balance out the error. It may be all on one side of the station, all plus or all minus, and then that's strictly an equipment adjustment. One of the first things we do is to balance that out. Then we go out some distance from the stations and see if we can reproduce this same basic error curve at that distance. You'll find areas where it doesn't coincide, and we can trace that down to terrain or polarization effect. Those are the answers we have to bring back to our people on the ground."

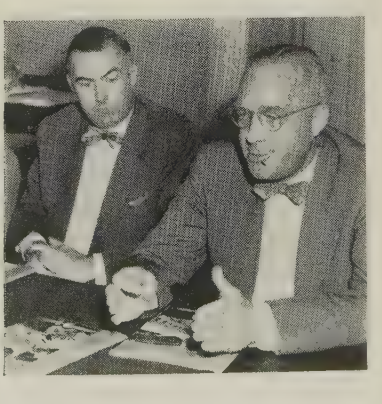
Frank C. White: *"Actually, Art is hiding his light under a bushel. He developed a very clever method of flight checking the VOR ground stations. This method is now known around the CAA as 'The Jenks System.' It's a system where you fly orbits around VOR stations at various ranges from the station. By flight checking a VOR station that way you certainly learn a lot about the accuracy of the omni facility being checked.*

"I'm surprised that we *(Continued on page 38)*



"WE HAVE *dual installation in our aircraft," Mr. Peterson stated, "and we have found little error"*

"STUDY *to determine holding airspace has not been completed," stated Mr. Thomas (left). Seated to Mr. Thomas' left is Capt. S. C. Hoyt*



"OMNIRANGE *is not as complicated as LF range." reported Mr. Stuart, (right), "and is easier to monitor"*

DC-3 TAKE-OFF

A resumé of the T-Category take-off performance specs as related to the DC-3 and its operation under varying conditions

by Captain Charles F. Banfe, Jr.

Today, there are more than 400 companies operating DC-3's as executive aircraft, and each day these aircraft are taking off under widely varying conditions from airports all over the world. In order to attack the problem of the DC-3's take-off performance, there must be a set of values for comparison—a series of tests by which the aircraft can be assigned certain performance values.

This was the problem which confronted the entire aviation industry more than 10 years ago—to establish requirements that would realistically represent a high standard of safety for the various categories of airplanes. The new regulations would deal with all characteristics of the airplane to insure safety in actual operations—its powerplant, structure, stability, control and performance at the airport and enroute. Conferences were held with the CAA, the airlines, the Air Line Pilots Association, and the manufacturers and, as a result, the regulations set forth today in the CAR Bulletin, Part 04, entitled "Airplane Airworthiness," were promulgated.

Prior to the new regulations all types of aircraft, including DC-3's, were regulated essentially by Bulletin 7A. Under this system the DC-3 had to equal or better rather arbitrary performance requirements, such as 1,000-foot take-off run at sea level at standard take-off weight, a 65 to 70 mph stalling speed at landing flap setting and a first-minute rate of climb at sea level in feet per minute equal numerically to eight times the stalling speed.

Though there are related rules for enroute and for landing, we will confine attention here to take-off and not deal with the entire problem of the Transport Category at this time.

The new requirements very carefully specify how an airplane shall take off and climb in order to be defined as a safe air carrier.

The take-off field length must be sufficient to permit the take-off to either be continued, in case of an engine failure, after V_1 or to stop it before V_2. After V_2, it must be able to clear obstacles by 50 feet.

There *are* other requirements but it must be remembered that the DC-3 has built up a remarkable safety record and though it might not be able to be licensed under the Transport Category, there are many parts of the take-off performance requirements which can be reduced to DC-3 level to give a clearer picture for "flight planning" a take-off.

In order that the completeness of the present standards be understood, the performance requirements for take-off as contained in Parts 04B, 40, 41, and 61 of the CAR are outlined below.

Description ▶

(Model—DC-3, Engines—S1C-G and S1C3-G)

A. The runway length required for take-off is based on two speeds:

V_1—Critical Engine Failure Speed—88 mph

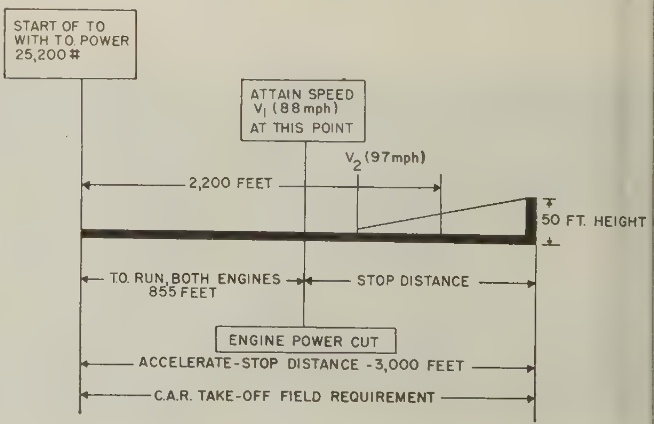
V_2—Minimum Take-off Climb Speed—97 MPH,

and is the larger of the following two distances:

(1) Accelerate-Stop distance is that distance required to accelerate to V_1 and stop on runway. (See Figure I)

(2) The distance to accelerate to V_1 and then, with the most critical engine inoperative, to accelerate to V_2 and climb at V_2 (97 mph) to a 50-foot height above the runway. It shall be possible to clear all obstacles by at least 50 feet vertically or at least 300 feet horizontally. In clearing an obstacle 300 feet horizontally, the airplane may not be banked

FIG. I ACCELERATE-STOP DISTANCE



TAKE-OFF PROCEDURE FOLLOWED IF ENGINE FAILURE OCCURS AT CRITICAL ENGINE SPEED AND PILOT ELECTS TO STOP, OR IF ENGINE FAILS BETWEEN V_1-V_2 THE PILOT MAY STILL STOP OR ACCELERATE TO V_2 AND CLIMB TO CLEAR A 50 FT. OBSTACLE.

before attaining an altitude of 50 feet and thereafter no more than 15°.

B. Take-off climb contains two requirements:

(1) First Segment. The intent of this First Segment Requirement is to provide, under standard conditions, a small positive rate of climb while the gear is retracting.

(2) Second Segment. This is the major take-off climb requirement. The rate of climb required is .035 times stalling speed (take-off configuration) expressed in feet per minute. The intent of the requirement is:

a. to provide sufficient climb for maneuvering and returning to the field after take-off, and

b. to require greater performance from airplanes with high wing loadings.

(*Item a* is determined by the factor .035 which is considered to provide a rate of climb sufficient to accommodate the atmospheric conditions expected.)

(*Item b* is determined by using the square of the stalling speed since this quantity is proportional to wing loading.)

There are no climb requirements in the third or fourth segments of the take-off path important enough to indulge in at this time.

An adaptation of the Transport Category to the DC-3 can be seen in Figures 2 and 3.

Discussion ▶ It must be borne in mind that the DC-3 was not designed to comply efficiently with Transport Category requirements, *i.e.*, the particular combination of wing loading, power loading and structural strength which exists in the airplane was not selected with that in mind. It clearly needs the installation of engines of greater power and an increase in the structural strength.

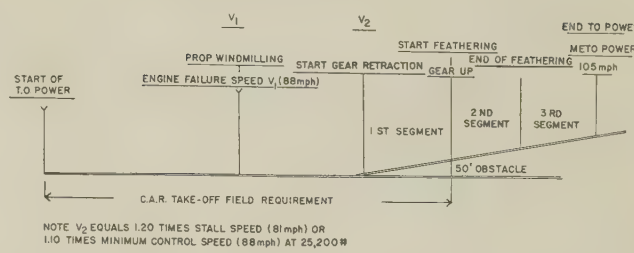
The following are component parts of the Transport Categorys' take-off performance as related to the DC-3, and its intent is only to aid the executive pilot in his take-off planning:

Runway Length—The accelerate-stop distance for a DC-3 is 3,000 feet. Because most runways are far longer than 3,000 feet, the runway-length problem is not too great.

If an engine fails completely before the aircraft has accelerated to V_1 (88 mph), the pilot must discontinue the take-off. However, if V_1 has been reached, it should be possible to continue flight; whether it is advisable to do so or not would depend upon pilot judgment. (Caution is urged in that the pilot must not attempt to maintain directional control with the brakes—he should use the rudder.)

If an engine fails after V_2 (97 mph), flight should be continued and will reach an altitude of 50 feet above the runway in a shorter horizontal distance if the gear is retracted immediately. It must also be remembered that V_1 (88 mph) is a figure for 3,000-foot runways. If the runway length is longer, then the accelerate-stop distance can be greater and conceivably V_1 can increase until it goes beyond V_2 (97 mph). That might mean that the aircraft could take-off, lose an engine and still land straight ahead.

FIG. 2 TRANSPORT CATEGORY PROCEDURE

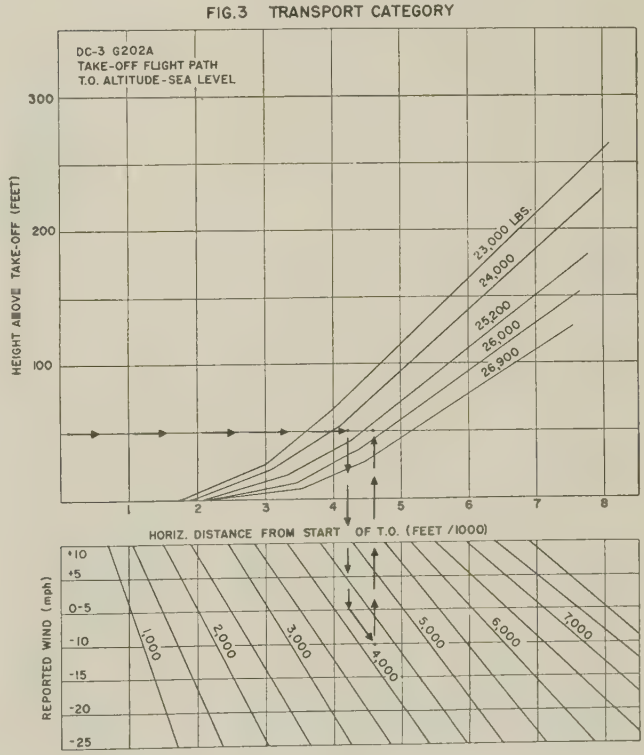


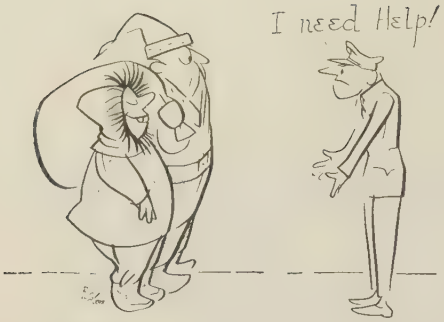
Slope—A downhill slope can compensate for other negative factors but here is a list for uphill slopes:

ALTITUDE	*MAXIMUM ALLOWABLE GROSS WEIGHT*	*CRITICAL % GRADE*
Sea level	26.200 lbs.	.94
1.000 ft.	26.035 lbs.	.72
2.000 ft.	25.880 lbs.	.54
3.000 ft.	25,725 lbs.	.38
4.000 ft.	25,430 lbs.	.26
5,000 ft.	24.930 lbs.	.195
6.000 ft.	24.175 lbs.	.14
6,200 ft.	24,000 lbs.	.00

(If gradient at airport is higher than shown for that altitude, the take-off is impossible at corresponding weight, regardless of available runway length, zero wind.) *(Continued on page 64)*

FIG.3 TRANSPORT CATEGORY





Performanc

from the Files of the Flight Safety Found

ICE ALOFT

An item I would like to mention which I feel deserves more thought is a better method for determining the amount of ice to be expected during icing conditions. At the present time all we can do is make a guess as to the amount of moisture that may be present. We have had certain conditions exist with a northeasterly flow of polar Atlantic air, which has caused considerably more ice than the weather report would indicate and also what the temperatures would lead one to believe. If some method could be developed whereby pilots could have a better idea on these conditions, certain altitude changes or prior preparation before entering the icing condition would help the operation of the flight and maybe take some of the guess work out of it.

ICE AGROUND

There is not much that the pilot can do about slippery runways and ice ridges concealed by snow except to lose no time in calling the attention of airport managers to dangerous conditions as he sees them. Also there is, as yet, no objective way for determining when a runway should be closed for "slipperiness." One might be developed if a few thousands could be spent on research. In the meantime will we go on cracking up to the tune of several hundred thousand dollars each year? The cost of one crackup would probably more than pay for the investigation and development of ways to prevent such accidents.

Look at the following incidents: Aircraft contacted an *ice rut, under loose snow*, and swerved suddenly to the left. Pilot was unable to regain directional control, and aircraft rolled through a snow wind row and off the runway. Substantial damage to the aircraft was sustained. Or this . . .

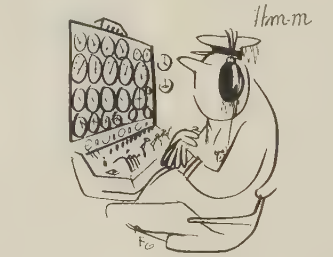
Approximately one inch of slush and water had accumulated on runway, which retarded acceleration of the aircraft after start of take-off and prevented raising nose-gear. Pilot abandoned the take-off and *found braking ineffective due to the slush*. Aircraft started to skid, and since pilot felt he could not stop on remaining runway, he used power on one side to increase the rate of turn, and went off edge of runway. The nose-gear broke as it contacted an island between runways, and aircraft came to rest in a nose-down-tail-high attitude. Aircraft received substantial damage.

CREW PERFORMANCE—ICING

The following story carries several additional lessons. Recounting this experience may save a lesson learned the hard way.

An air transport entered an overcast at 18,000 feet where light icing was indicated, so all de-icers and carburetor heat were applied. A gradual loss of airspeed was not

corrected by a descent to 16,000 feet and the use of additional power. Course was reversed, with further descent to 15,000 feet, and application of METO power was required to maintain airspeed of 150 to 155 mph. Although wing and tail de-icer temperatures remained normal, the cabin-heater fuel pressure dropped to 10 lbs. and smoke odors appeared in the cabin and cockpit, presumably caused by icing of the cabin air intake. The cabin heaters were turned off and pressurization was partially released. Captain's airspeed indicator started a gradual increase and his altimeter indication remained at 14,000 feet, but the copilot's instruments showed 135 to 140 mph and 11,500 feet. *Flight engineer noticed this discrepancy but did not consider it necessary to mention it to the captain.*



When the airplane shuddered under a partial stall, the captain realized that his instruments were incorrect and applied emergency power of 50 inches manifold pressure and 2700 rpm for about 30 seconds. Shortly thereafter the craft broke out of the overcast, lost the ice, regained normal speed, and landed safely at origination point.

Reports indicated that wing ice was spotty

and approximately 6 inches thick in plac windshield was iced solid, and side windo were partly iced, and top and bottom of fu lage were heavily iced, as evidenced by pie having dropped away after normal cruis speed was restored in clear, warmer air, which time the captain's instrument readi operated normally.

The copilot reported that upon occurre of the partial stall he switched to his al nate static source and verified the correctn of his instruments. It was concluded that extreme icing conditions encountered, w high liquid water content and large drop at outside temperature of 15°F, were resp sible for ice formation far enough back the fuselage to affect the performance of instrument static system, causing the err in the captain's instruments. Ice also parti blocked the airfoil scoops interfering s ciently with the cabin airflow to cause odors. There was no evidence of oil leak through the supercharger seals into the stream, no oil was found in the ducts and duct joints were secure. Air-conditioning de-icing system were found satisfactory.

Altitude is a Safety Cushion

Hindsight forecasting indicates that, in particular case, it would have been better go through the area at 20,000 or 22,000 f which would probably have put the flight top judging from the experience of flights the area somewhat later. Generally speak given the probability of moderate to he icing conditions, fly high rather than l and this is particularly true of some course, off-airways routes over rugged rain. You can always come down, but can't always go up.

Use All The Resources at Your Command

The second point made is that of alw using the alternate static source when in a thing other than a light icing condition. is particularly true when ice formation on side windows of the cockpit warns that t is probably ice on the side of the fusel and that is where the static vents are loca

PITFALLS

Jerome Lederer and Robert Osborn

Ahead of Coming Events

a third point, remember the necessity eeping the airspeed up before a point ched at which the use of full power bes necessary. If the airplane is acquiring of ice and an attempt is made, after a of airspeed, to maintain altitude and eed by pulling up the nose and applying r, the results are likely to be bad.

For Other Consequences

the case mentioned above, the cylinder temperatures were rising rapidly due to s power being used, and the cowl flaps opened to a considerable degree, further asing the aerodynamic drag on the air-. Keep the nose down and the airplane he step".

on Continuous Cross Checking

e fourth point is one about which many ins have instructed their copilots and eers, and which is certainly sound prac- This point is that whenever any one of rew members notices something in the oit which to him is not quite right, he d in every instance bring this to the tion of the captain and should not as- that the captain is aware of the irreg-y. The captain should purposely create ation to keep the crew alert.

IN THE HEAD

C-47 aborted a take-off due to frozen air- heads. The airspeed heads were proper-vered and the airplane remained parked le from Friday night until Monday ing, each night of which freezing condi- prevailed. Upon returning to the line londay morning (the weather still was J but temperatures below freezing) from borted take-off, pitot heat was applied nally to the head and the airspeed indi- responded.

e head is a standard one used on all and DC-3's, and usually regulations state pitot heat should not be used until the airplane is airborne to prevent overheating. Some airlines, I believe, require the application of pitot heat at low outside temperatures before leaving the line. Good preflight operation surely requires a hand check of the pitot tube to see that heat will be available.

I am not convinced that atmospheric humidity and breathing of the tube could condense sufficient water to block any passage but rather, as in that old case once cited, maybe the drain holes were dirty and plugged by metal polish or other debris. I do believe further that more attention should be given to check airspeed heads before take-off because a take-off into a very low overcast with poor visibility without a primary flight instrument could have been hazardous until cleared by the pitot heat.

To sum up, we had a frozen airspeed head and I do not believe we sufficiently checked before take-off.

NOTE:—APB 50-6 also suggests preflight warming up of cockpit to take stiffness out of oil so that instruments will operate more freely.

SAFETY TIPS FOR WINTER OPERATIONS

There is often a thin coat of ice under the fluffy blanket of snow which has accumulated on the wings of your plane. Don't depend on the snow blowing off during take-off, even the light kind, and check for ice. Falling snow sticks at temperatures above 10°F. It also forms a coat of ice between 32° and minus 10°F.

Snow-grip tires should be on all aircraft flying into icy runway country. Even the best brakes will not stop an aircraft that is skidding down an icy runway. Every winter there are a few accidents of this nature which could have been prevented. The heavier transports seem to be especially addicted to the long skid, when not properly equipped.

Snow or ice covered runways require that short-field landing techniques be employed at all times since braking action is at a minimum. Instead of landing short, the common tendency, due to optical illusion, is to land long.

Propeller pitch should be changed occasionally during cruise, to prevent oil congealing.

Cold, and the necessity of wearing heavy flying equipment tends to lower pilot efficiency. The physiologists say that many of the same symptoms which are associated with hypoxia have been noticed in pilots who are subjected to extreme cold. However, this is not dangerous, just a matter of expecting it and being a little more alert than usual.

There is no way accurately to estimate the number of inches of snow on a runway. If an airport is not being used, stay away from it, unless you have an emergency. One pilot "estimated" that there were two inches and landed on his back. There was an airport with cleared runways not far away.

Night take-off accidents involving loss of directional control and collision with snowbanks point up the necessity for being really on your toes under these conditions. A slight veering to the left would ordinarily not be noticed, but when there is a snow-bank in that direction the veer ends up as an accident statistic.

MONITOR OUTSIDE AS WELL AS INSIDE

Words of caution that are well worth repeating requests all pilots to monitor continually not only the clearances given them by Air Traffic Control but also the clearances issued to traffic in the immediate area. One recent case provides an example. Although the incident has not been completely investigated, the reliability of the captain involved indicates the descent was accurate during his approach to an important ATC area. On two occasions on descent he was able to pick up errors and oversights, one on the part of ATC Center and the other on the part of another flight which had not heard the clearance given it.

It is always very important that all crews flying into any congested area be constantly alert to the clearances they receive as well as the clearances given to other flights in the area.

SKYWAYS FOR BUSINESS

NEWS NOTES FOR PILOTS, PLANE OWNERS OPERATING AIRCRAFT IN THE INTEREST OF BUSINI

EXECUTIVE A-26, *converted for Brown Paper Mill, Monroe, La., by Grand Central Aircraft, features cabin pressurization; at 17,500 feet, cabin "altitude" is 7500 feet*

New Douglas A-26 Conversion Features Cabin Pressurization

Glendale, Cal. There are several converted Douglas A-26 aircraft flying the business skyways today, but one in particular is commanding the attention of business-aircraft owners and operators everywhere. This one is an A-26 recently converted for H. Lutcher Brown, President of the Brown Paper Mill of Monroe, Louisiana, by Grand Central Aircraft. Principal feature of this conversion is the pressurization of the cabin—while actually flying at 17,500 feet, the "cabin altitude" is 7500 feet. Project engineer for this difficult undertaking was P. C. Medina who obtained a leave of absence from the Glenn L. Martin Co., to do the job. Working with him were W. W. Reaser, chief air-conditioning engineer of the Douglas Aircraft Co., Mr. Ted Grohs, prospectus engineer, Mr. Wayne Goldie, mechanical engineer, Mr. W. Sharp, stress engineer and Mr. Landis Carr, shop supervisor. Mr. Medina and his staff worked some three months before actual construction started on the plane.

The oblong shape of the A-26's fuselage and its glass-canopied cockpit posed complex problems, and the cabin, fuselage and cockpit had to be redesigned and strengthened to withstand maintenance of a 3.1 pressure ration. This entailed heavier and stronger frames, pressure bulkheads fore and aft, heavier gauge skin material and application of a special sealant to guard against possible air leakage. AiResearch pressurization equipment was used.

At Mr. Brown's request, several changes were made in the cabin for comfort's sake. The rear bulkheads were moved so the backs of the four seats could be fully reclining. Large windows were installed to give maximum visibility, and an observation dome was put in that enables a 6-ft. passenger to stand upright and stretch his legs on a long trip. Ceiling and walls of the interior are covered with hand-tooled fine grain leather. Predominant colors are black and yellow, with green trim, and signs of the zodiac in bronze and gold are embedded in the leather. A black wool pile rug covers the plywood floor, and lights are indirect fluorescent. The pilot, copilot and passenger seats are upholstered. Other appoints in this business A-26 include a magazine rack, lavatory, wash bowl, food locker, radio and telephone.

The Brown Paper Mill plane is powered by two Pratt & Whitney R2800C-83AM3 engines with Hamilton Standard reversible propellers. It has a cruising speed of 340 mph at 17,500 feet, and a top speed of more than 400 mph. Range is 3400 miles, and gasoline capacity, 1600 gallons. The gross weight of the newly converted business aircraft is 26,500 pounds.

No cost figures have been released on the conversion job as yet, but estimates place the total amount at more than $500,000.

Pilot of the plane is Col. Walter G. Clarl flight engineer is R. G. Greenman.

Pacific Airmotive Signs as Distributor for Godfrey Engineerin

Burbank, Cal. Pacific Airmotive Corp. r cently signed an agreement to become the clusive U.S. distributor for aircraft equ ment designed and manufactured by George Godfrey and Partners, Ltd., of E land and its Canadian subsidiary, Godf Engineering Co. Under the terms of this agreement, PAC will handle Godfrey airc turbo refrigeration equipment, cabin su chargers, aircraft fans, water separators, craft silencers and ground air-conditioner

Widening the international scope of Pac Airmotive's aviation activity, the Godf agreement is in addition to PAC's earlier tract with de Havilland Aircraft, wher PAC acts as exclusive servicing representa and main supplier of parts for the de Ha land *Dove*, many of which are in use as b ness aircraft.

New Twin-Engine Navion Introduced by Assoc. Mfg. & Eng. Co.

Dallas, Texas. Darrell White, Presiden the Associated Manufacturing & Enginee Co., was a recent visitor at Southwest motive at Love Field. Mr. White and his chanic, Lee Foley, brought in their compa new twin-engine *Navion*, designated W and converted by Associated Manufactu & Engineering Co. Designed in 18 mor the WE-1 is powered by two 225-hp C tinental engines that give it a cruising sp of 185 mph and a 2,460-fpm rate of cli

NAVION WE-1 *is twin-engine conversion by Associated Manufacturing & Engineering Lee Foley (left) and Darrell White, president of the company, flew the plane to*

Wingtip tanks of 35-gallon capacity each augment a 40-gallon fuselage tank.

Other features of the WE-1 include Hartzell full-feathering constant speed propellers, placement of accessories behind the engines for a flattening and lengthening of the nacelles, Fletcher augmentor tubes on exhausts, use of circuit breakers throughout, a footstep in the flap, both nose and tail baggage compartments, dual controls and full instrument flying equipment. The twin-engine *Navion* weighs 3,895 pounds, approximately 1200 pounds more than the single-engine North American *Navion* from which the WE-1 was converted.

Mr. White, who calls the conversion a "big little airplane," reports his firm plans to produce the aircraft commercially and expects to expand its original facilities in Hangar 1 at San Antonio Municipal Airport.

Mustang Aviation Opens New Hangar at Dallas' Love Field

Dallas, Texas. Mustang Aviation, Inc., since 1939 operators of Mustang Airport, has opened a new service hangar and sales building at Love Field. Mustang Aviation will continue to operate the Mustang Airport for flight training purposes, but all other business is being transferred to the new headquarters on Love Field. Also affiliated with the National Air Taxi Service, Mustang Aviation's air taxi service now operates out of Love Field, providing charter flights to off-airline destinations. Passenger interchange agreements have been signed with 17 leading airlines. Mustang's late-model, CAA approved air taxies (both single and multi-engine) are being used regularly by Dallas business executives. The Mustang Aviation hangar is located at the south end of Love Field. An adjacent building houses the firm's offices, the parts room and pilots' lounge.

Low Registration Numbers Now On a Cash Basis

Washington, D.C. From now on, if you want a special registration number for your airplane, it will cost you $10.00. According to a report from the CAA, so many plane owners have asked for special numbers that it has been forced to request a fee to defray the expense of the extra work and effort involved in making such assignments. The convenience of having a low number or simply a favorite number seems to be worth $10 to many owners, the CAA says, and they anticipate continued business in this field. Numbers become available when they are turned in by previous owners, when a plane is no longer in service, or when a new number series is introduced.

In addition to the prefix "N", an aircraft registration number may not exceed five symbols which may consist of one to five digits; one to four digits followed by one letter; or one to three digits followed by two letters. All letters of the alphabet are used except "I" and "O" which are not authorized because of their similarity to figures.

Requests for special registration numbers must be made to the CAA, Aircraft Engineering Division, Administrative & Records Branch, W-240, Washington 25, D.C., and be accompanied by a money order for $10.

.... in the Business Hangar

The Zollner Machine Works of Fort Wayne, Ind., has purchased a DC-3 from United Airlines, and the aircraft will be used to fly the Zollner Pistons, a famous basketball team, around the country to meet their schedules. Modification of the DC-3 into an executive type airplane is being done by Grand Central Aircraft. The plane is being fitted to accommodate company officials on business tours as well as the company's athletic teams.

Marshall V. McDowell, chief pilot for The Hoover Co., brought his company's DC-3 into Aerodex at Miami for minor service. On this trip Pilot McDowell was flying without copilot-mechanic, Dave Adams. Dave suffered a nasty fall and is hospitalized in North Canton, Ohio, home base for The Hoover Co. The company is a member of the National Business Aircraft Association.

The *Lodestar* owned by the Sunray Oil Co., of Tulsa, Oklahoma, has been equipped with a Flite-Tronics MB-3 marker beacon receiver. Installation was made by Spartan Aircraft Radio Sales.

Rip Strong, pilot of National Dairy Products Corp. DC-3, Ed McFee, pilot of Davison Chemical Company's DC-3, and Charles Sharp, pilot of Great Lakes Carbon's Douglas, brought their aircraft to Remmert-Werner for installation of Sperry A-12's. Both National Dairy Products and Great Lakes Carbon are members of NBAA.

The Houston Oil Company's *Lodestar* was in the shop at Southwest Airmotive for electrical, line service and radio work. Pilot W. E. Huttle renewed old acquaintances around Southwest's operation while his plane was being worked on.

Bill Powell and Walt Mimms, pilot and copilot of Delhi Oil Company's *Lodestar*, have the plane back in the air after reskinning and a complete reseal by Aircraft Tank Service in Pacific Airmotive's hangar at Burbank. Don Beeler is chief pilot and Delhi's NBAA representative.

Aeronautical Radio Mfg. Co. recently completed the installation of Flite-Tronics MB-3 marker beacon receivers in Cities Service Oil Company's Lodestar and Executive B-26.

E. T. Barwick Mills of Atlanta, Georgia, a large rug manufacturing company, has taken delivery of a Lockheed *Lodestar* converted by L.B.S. Aircraft Corp. at Miami, Florida.

George Meyers, pilot of Monsanto Chemical Company's DC-3, "Catalyst," had Remmert-Werner install Collins dual 51R3 VHF receivers, with dual omni and dual radio magnetic indicators. Ralph Piper is Monsanto's chief pilot and NBAA representative.

B. F. Goodrich company had pilot H. R. Earnest take delivery of its *Lodestar* at Lockheed Aircraft Service—International, at N. Y. International Airport, after a tank sealing job.

George Vaughan, chief pilot for Phillip's Drilling Corp., San Antonio, brought his company's new Aero *Commander* to Horton & Horton Upholsterers, at Houston Municipal Airport, for a "pilot-designed" custom interior of green leather. Also at Horton & Horton for refurbishing is the Holmes Drilling Company's Twin-Beach. John Hammett is its pilot.

A new Remmert-Werner Deluxe Executive DC-3 was recently delivered to Burlington Mills, of Greensboro, N. C. The plane is powered by R1830-Super-92 engines, and is equipped with Collins radio and a Sperry A-12. Shelby Maxwell is Burlington Mills' chief pilot and NBAA representative.

Lodestar N-66K, owned by R. F. Windfohr, prominent Fort Worth ranch owner and oil well operator, went through relicensing inspection and landing gear work at Lockheed Aircraft Service, Burbank, prior to leaving on a flight to the Far East. The *Lodestar* was flown away by Charles M. Baudoux, with Tom Armisted as copilot. On the trans-Pacific crossing, Mr. Windfohr was accompanied by his wife and teen-age daughter.

Joe Clemow, chief pilot for Eastman Kodak, has been busy in St. Paul while his company's DC-3 gets a new interior conversion, installation of a rear baggage compartment and an air-stair door. Work is being done by Northwestern Aeronautical Company.

Official NBAA Report

NATIONAL BUSINESS AIRCRAFT ASSOCIATION, INC.

(formerly Corporation Aircraft Owners Association)

National Business Aircraft Association, Inc. is a non-profit organization designed to promote the aviation interests of the members firms, to protect those interests from discriminating legislation by Federal, State or Municipal agencies, to enable business aircraft owners to be represented as a united front in all matters where organized action is necessary to bring about improvements in aircraft equipment and service, and to further the cause of safety and economy of operation. NBAA National headquarters are located at 1029 Vermont Ave., N. W. Washington 5, D.C. Phone: National 8-0804.

A Report on the Pilot's Weather Verification Program

This program was conducted to gain information on the usefulness of the weather services received by pilots from the Weather Bureau and CAA Communications Stations. Basic data for this survey were obtained through wide distribution of the specially prepared Pilot's Weather Verification Report cards. These cards were filled out by NBAA member-pilots making cross-country flights in February, 1953.

The month of February was chosen for a test period because it was thought that the rapidly changing and frequently severe weather conditions common at that time of year would provide a better test of briefing service, notwithstanding the smaller amount of private flying done in February.

Out of approximately 215,000 cards distributed, 1,161 were completed for flights during the test period and returned to the Weather Bureau. The relatively small return is believed to reflect the limited amount of personal flying in February rather than inadequate card distribution or lack of pilot cooperation.

The great majority of the replies indicated satisfaction with services rendered. The following indicates the rating made by the pilots of the briefing services, irrespective of the briefing source:

Briefing rated satisfactory: Adequate, 493 or 42 percent; very helpful, 513 or 44 percent; total, 1,006 or 86 percent. Briefing rated unsatisfactory: Inadequate, 135 or 12 percent. Not rated: 20 or 2 percent.

An analysis of the briefing sources and their relationship to the briefing rating follows:

Briefing obtained in person: Adequate or very helpful, 330 or 90 percent; inadequate, 36 or 10 percent; total, 366 or 100 percent. Briefing obtained by telephone: Adequate or very helpful, 470 or 87 percent; inadequate, 73 or 13 percent; total, 543 or 100 percent. Briefing obtained air-ground by radio: adequate or very helpful, 217 or 90 percent; inadequate, 24 or 10 percent; total, 241 or 100 percent. Grand totals: Adequate or very helpful, 1,017; inadequate, 133; total, 1,150. Note: Eleven cases were not included as they did not indicate method of obtaining weather information.

Personal Visit to Weather Bureau Deemed Best for Pilot

These figures suggest it is more satisfactory for the pilot to obtain his pre-flight weather information by personally visiting the Weather Bureau or CAA office.

The relatively favorable showing of the aeronautical radio as a source of weather information, rated about equal to "in person" in this survey, requires some explanation. It seems likely that this is the result of two factors. One is the short interval of time between the pilot's obtaining weather on the airplane radio and applying this information to the conduct of the flight.

As the lightplane pilot in flight is not generally concerned with weather developments more than an hour or two in the future, the latest available weather information broadcast on the CAA radio range is very likely to approximate the conditions he encounters. With the longer time interval involved in pre-flight briefing, it is necessary to base the weather briefing on prognostic charts and forecasts.

In these circumstances, possibilities for the expected weather conditions to be at variance with those actually observed in flight are considerably increased. Also, when in flight the pilot will concentrate on the one or two reports with which he is directly concerned, but in a weather office before take-off he probably will check many items. They include the latest sequence, pibals, forecasts, and the surface and upper-level charts, both current and prognostic.

Thus, it is evident that with the expectation of changeable or marginal conditions, it may be very difficult for the pilot to recall all information obtained in the office even though it may have been substantially correct and all the more reason for him to obtain later information by radio while in flight.

Inflight and Post-Flight Reports Submitted by Pilots

This tabulation indicates that Pireps were filed for 22 percent of the flights during this period. Perhaps of more importance is the percentage of Pireps filed by pilots who considered their initial weather information to be inadequate (32 percent). This classification generally indicates marginal or variable conditions, eliminating the flights under CAVU conditions where a pilot report would have a limited value. However, even in this category only 32 percent filed a report.

Another point that became apparent in the course of reviewing the cards was that many of the pilots apparently made no distinction between "forecasts" and "reports" of actual conditions. Possibly as a result of this there appeared to be a marked tendency on the part of the pilots to use current weather data such as pibals and sequence reports rather than the forecasts of these items when they were obtaining their pre-flight weather briefing.

What is Being Done to Improve Briefing Service

Here are several things now being done o that can be done to help increase the valu of weather information furnished to the pilot.

The Bureau is training its personnel to b better briefers through a comprehensive pilo briefer training course now being given t briefing personnel at all airport stations.

The Bureau is continuing work to mak weather information more usable to th pilot by adopting self-explanatory, stand ardized weather displays at airport station throughout the country.

The Bureau is processing all pilot weath er reports of significant weather condition to provide for local briefing use and tele typewriter distribution, and will be glad t handle many more.

The pilot should make it a point to fil Pireps, particularly when the weather en countered presents possible hazards to th continuance of flight operations and/or i different from the forecast.

The pilot should in general refer to *fore cast* information valid at the time of hi flight, rather than use the observational dat exclusively. It should be emphasized that a observation represents conditions *only* as the *were* at a given spot and at a given time Conditions can and frequently do vary con siderably with any change in either locatio or time. Aviation forecasts, while not 10 percent correct, provide the best availabl indication of the weather that will be en countered in flight and can provide a saf "out" in marginal conditions. In some case of course, a safe "out" would be to dela the flight to wait for a more favorable weath er situation.

USAF Caribbean-South America Radio Charts Now Available

As a result of an Air Force-Department o Commerce agreement in the Air Coordinatin Committee, the Aeronautical Chart and In formation Center of the USAF has advise that it will make the Caribbean-South Ameri can radio facility charts available to Unite States civil aircraft operators under the fo lowing conditions:

1. Single copies will not be sold as such but the U. S. Coast and Geodetic Survey wi accept a customer's $3.50 per year, whic will be forwarded to Aeronautical Chart an Information Center, St. Louis, Attn: ACD for entry on the regular subscription list.

2. Upon receipt of subscription reque and funds, the U. S. Coast and Geodetic Su vey will supply customer with a current cha at no additional cost and the ACIC will carr out the balance of responsibility for annu subscription material. Initial subscriptio should be mailed to the Director, U. S. Coa and Geodetic Survey, Washington 25, D. C

CA is a Vital Force in ation Development

o little has been said about the out- ding technical work being accomplished the Radio Technical Commission for onautics of Washington, D. C., on behalf merican aviation.

TCA is an aeronautical radio and elec- cs problem-solving organization which sed the U. S. Common System of all- her air navigation and traffic control *(see 16)*. It is a non-profit, cooperative as- tion of all U. S. industry and government nautical telecommunications agencies and general membership includes nearly 100 nizations, both civil and government, tified with aeronautical telecommunica- s.

he objective of RTCA is to advance the ice of aeronautics through investigation vailable or potential applications of tele- munications and their adaptation to rec- zed operational requirements.

conducts studies of existing and pro- d systems of aids to navigation, communi- on and traffic control to determine their bility and fosters new developments to aeronautical operating needs. It co- nates government and industry views on tion telecommunication matters and for- tes recommendations on the basis of e views.

TCA is a means of creating cooperation coordination in the highly complex field viation radio, thereby unifying the plan- of all interested agencies. It is the only nization which brings together, at a e table, the government and industry ad- strators, designers, engineers, pilots, and ufacturers, aircraft owners, and airlines ators. It enables its members to evaluate successes and failures each has encoun- l in solving problems of aeronautical munications and aids to navigation, with sharing in the common experience.

was established in 1935 when the De- ment of Commerce invited all U. S. cies, government and non-government, erned with the development, application use of radio in aeronautical operations orm an organization for the coordination heir efforts. It is not an official agency of United States government.

TCA is managed by an executive com- ee comprising one representative each of following: Departments of State, Treas- Army, Navy, Air Force and Commerce; eral Communications Commission, Civil onautics Board, National Business Air- t Association, Aeronautical Radio, Inc., Transport Association, Aircraft Industries ociation, Radio-Television Manufacturers ociation, Air Line Pilots Association, and raft Owners and Pilots Association.

he technical work of RTCA is performed special committees established by the utive committee. Each such committee ies a specific problem and is dissolved n its work is done. Its members are spe- ists chosen for their knowledge of the sub- under consideration rather than their ation with member organizations of A, and representatives of all agencies wn to be affected by a specific study are ted to participate.

he Collier's Trophy, awarded annually the greatest achievement in aviation in erica," was won by the RTCA in 1950 the "establishment of a guide plan for the development and implementation of a system of air navigation and traffic control to facilitate safe and unlimited aircraft operations under all-weather conditions."

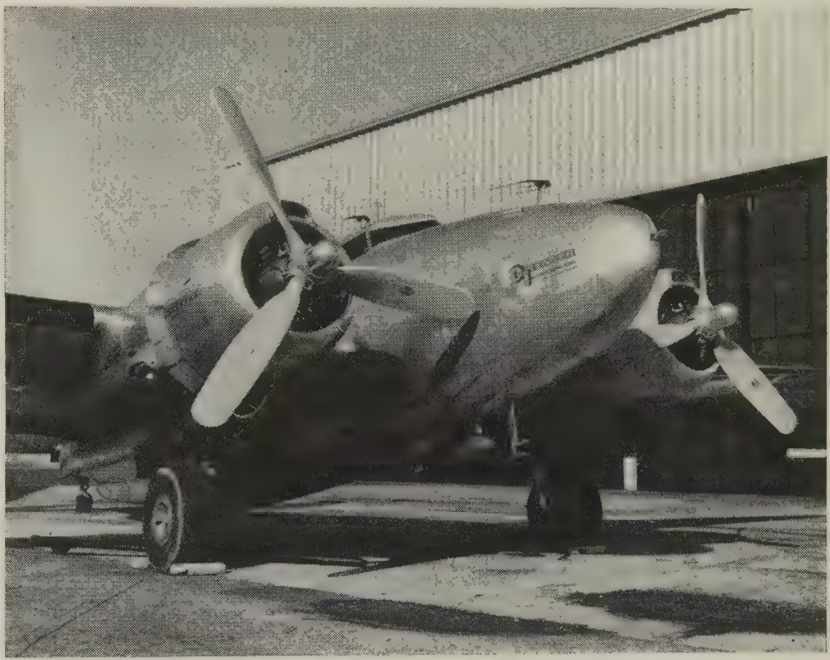
"Airline Distances" Publication a Help to Business Pilots

Special publication N. 238 entitled "Airlines Distances Between Cities in the United States," by C. A. Whitten, published by the Coast and Geodetic Survey, is a valuable aid for cross-country flying. It contains 246 pages of interesting data, in addition to the airlines distance figures. This includes latitude and longitude methods of computing airline distances, fundamental tables using the Lambert Project Radii, and many other useful computations. It is on sale by the Supt. of Documents, U. S. Gov't Printing Office, Washington 25, D. C., for $1.75 per copy.

Magnetic Memory System To Aid Air Traffic Control

To facilitate air traffic control, a magnetic memory system electronically storing and comparing flight plans of up to 2,000 airplanes simultaneously, is being developed for CAA by Remington Rand under the guidance of the Air Navigation Development Board. It should be ready for testing by fall.

Main advantage of the system is speed in processing large volumes of information. The system in filing flight plans records places and times of departure and arrival, check points over which aircraft are to pass, speed, fuel load, and aircraft data. This information is compared with other flight plans already recorded on magnetic surface (with the system searching through 2,000 plans in less than half a second) and revised, canceled, or brought up to date as required.



Dresser Industries' PV-1

The Lockheed Ventura (above) owned and operated by Dresser Industries enjoys two distinctions: it is the only PV-1 converted to business use that saw service in U. S. Navy: and it was first PV-1 to be converted. Original conversion was done by Spartan; later redone by AiResearch. The plane seats 12 and crew of two, and is equipped with dual instrumented panel that includes VHF, omni, dual ADF and also a Hughes Obstruction Radar. It also features a new Flite-Tronic marker beacon receiver that is not affected by TV. Cabin comfort is maintained by Barber-Coleman heating and air-conditioning unit. Chief pilot and NBAA representative is Larry Montigny (on right in photo left). His copilot is A.E. Hunter (on left).

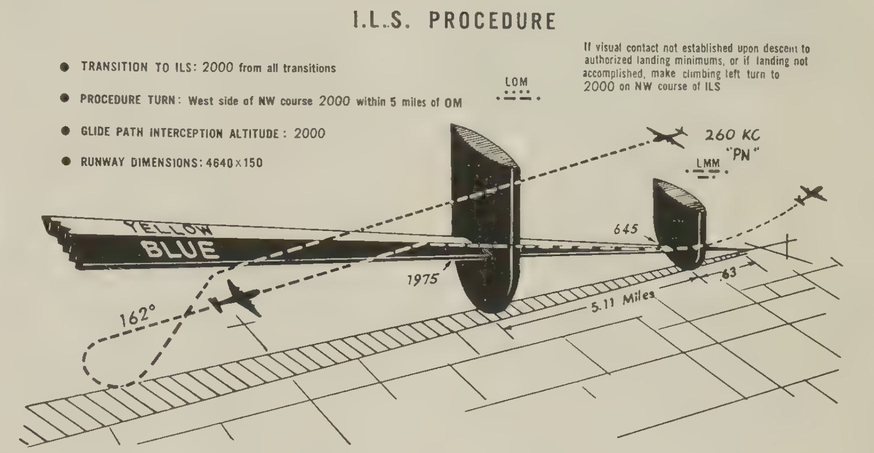
Cure Instrument Hypnosis with Approach Check-list

One of the most significant factors coming into greater prominence today with the increase in both VFR and IFR traffic on airways and into metropolitan terminals is the subject of self-hypnosis. Becoming more familiar and the subject of great concern to road traffic experts, this phenomenon has been suspected of causing many fatal accidents on long smooth, straight highways and turnpikes and during night driving. Somewhat akin to sleep-walking, an individual exposed too long to virtual concentration on a shiny, heat-waving highway surface and the continuous glare of opposing headlights can become something less than fully conscious with eyes wide open.

Given a shiny, focalized point of concentration, basic tool of the hypnotic entertainer, many persons if not actually put to sleep can attain a state wherein they can look danger in the face and not be aware of the threat. Under instrument flight conditions the necessity for such undivided concentration, at times, on the various flight instruments (and especially the low instrument approach aids such as an ILS Localizer course needle or ADF needle), may explain some otherwise unexplainable accidents. Under such circumstances the beckoning Localizer needle could well become the equal of the traditional venomous serpent staring the helpless bird to its disastrous end.

Some very competent pilots have not been too ashamed to admit their brushes with disaster resulting from this factor, sometimes called "ILS fascination". One instance recently reported by a top flight airline captain tells of making an ILS approach at a major terminal at which GCA, or radar monitoring, was available. Although only recently have such radar "advisory" services become automatic below certain weather limits, this pilot preferred to request the service.

In the course of his approach, he reports that he had the localizer course and glide path "tied down" by the time he left the outer marker on final letdown. As he proceeded, in reasonably calm conditions, he heard the radar controller "advise" that he was dropping below the "GCA glide path". This first advice he discounted because prior knowledge of the existence of a slight discrepancy between the ILS and GCA glide paths at this facility readily justified the report to him despite the fact that his glide path needle clung tenaciously to the indication of a perfectly flown glide path.



RATE OF DESCENT *in making an ILS approach is 430 fpm if coming in at 100 mph; 515 fpm at 120 mph; 615 fpm at speed of 140 mph; and 690 fpm if coming in at 160 mph*

It was only when further along into the more critical phase of his let-down, when the GCA controller advised he was getting dangerously below the safe glide path, that he woke up to the fact that his instrument showed the warning flag across the origin of the glide path needle, advising him that his glide path receiver was inoperative. Needless to say, the situation was saved by his attention to the radar advisories, but the fact was that he was letting down into disaster while staring fixedly at an instrument indication warning that was designed specifically to prevent just such an accident! The results under minimum conditions at the majority of fields not equipped with radar monitoring are obvious.

Inquiry among numerous radar operators reveals that such instances where aircraft are observed to descend below both outer and middle marker approach minimums well in advance of the markers are not at all rare. Judging from the known high standard of excellence of the crews involved, it appears obvious that some factor other than deliberate disregard of safe IFR procedure must be involved.

Following the inevitable trend toward increased instrumentation, it almost seems necessary to suggest that an instrument to effectively maintain the pilot in an attitude of alertness may be the next step. In fact, one of the services is experimenting with just that sort of thing to break up the "bulldog" concentration of combat pilots on a primary target or opponent to the extent that he becomes a "sitting duck" for other enemy pilots!

For the present it appears advisable to develop one's own check list or procedure for cross-checking proper function of all components during a low IFR approach.

Radar Advisories Again Automatic

The Washington office of CAA has announced that the earlier practice of CAA Radar towers automatically giving advisories on all IFR approaches, will again be resumed subject to certain exceptions. It will be remembered that the practice was stopped for several reasons, principally because some pilots objected to what they deemed "spying" on the manner of their approaches and second because it became painfully obvious that many pilots were ignoring the service, leaving the controller in the position of continually wondering if he were talking to himself.

With the exception of companies and services who made blanket requests for "advisories" to all their pilots, it became procedure for any pilot desiring the service to request it at start of his approach. If not requested, the controller silently "monitored" the approach, and if it appeared to exceed safe limits indicated on his scope, he broke in on the active communications or navigational frequency with an unsolicited advisory.

The relationship of GCA "advisories" to the pilot's conduct of his own approach is better understood apparently, because CAA advises that sufficient re-

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Radar Advisories Again Automatic

(Continued on page 35)

quests have been received for the service now to warrant resuming automatic advisories to all aircraft in the interests of safety. Some pilots have indicated a desire to receive the advisories on the active control frequency. The workload on these frequencies makes this an impractical solution. Therefore, unless otherwise advised or arranged, this service may be expected on the associated ILS voice channel. In this respect, it should not be confused with the radar service, such as departure and other control functions, supplied on other VHF frequencies.

Also the service will normally be provided only in association with the ILS approach with which the PAR, or Precision Approach Radar, is aligned. Similarly, the automatic service will be provided only when weather at the facility concerned falls below the highest IFR approach minimums. Thus, with weather adequate for "circling approach", radar advisories will not be automatically given.

Radar Separation Misunderstood

In a recent Accident Prevention Bulletin issued by the Flight Safety Foundation, emphasis was placed on a popular misconception of many pilots as to the true role, capabilities and limitations of radar with respect to the separation and protection afforded.

Primarily by quotations from the experiences of air-carrier pilots operating IFR plan during marginal or VFR weather or flight conditions, it was pointed out that radar cannot undertake to safeguard and separate the pilot from other aircraft operating VFR. Such information as the radar controller can make available to the pilot regarding other aircraft observed on his scope can only be subject to the workload imposed by the application and assurance of radar separation between known IFR traffic.

Usually lacking altitude information on any aircraft except those under his direct control, both advisories and evasive vectoring to avoid observed VFR traffic that might be separated by thousands of feet from the pilot concerned, become impractical. Thus, when practical and other duties permit, a radar controller may advise a pilot of a target on a constant bearing or potentially conflicting course to assist him in overcoming the natural blindspots of the cockpit. He cannot undertake to guarantee such service or, worse, attempt vectoring away from an observed target and smack into a previously unobserved target. It might be unobserved for a variety of valid reasons: aircraft just climbing into the antenna pattern limits, or descending; emerging from a radar "blind spot"; or moving at that exact but not infrequent tangential velocity with respect to the transmitting, and receiving antenna at which radar "cancels out" a target.

On the plus side, radar does and can assuredly give guarantee of separation between two or more *known IFR aircraft under its control.* It also provides considerably reduced separation minimums in the interest of expediting traffic flow. Thus, where ANC/IFR separation standards require variously three, five, 10 and 15 *minutes* of separation between aircraft, a minimum of three *miles* can often be employed between descending, climbing, enroute or crossing aircraft under positive radar identification.

So the paradox, where pilots sometimes complain about the inadequacies of the service in VFR weather (when most collisions occur) and often complain about the increasing use of radar reduced separation in IFR weather (when collisions have been almost nonexistent).

Air-Aids Spotlight

ALBANY, N. Y. *ILS installation 109.5 mc and 332.6 mc due for early commissioning serving Runway 19. Frequencies of LOM and LMM to be announced at same time.*

CROSSVILLE, Tenn. *VORW commissioned on 113.4 mc, located 47 miles 106° magnetic from Smithville low-frequency range.*

BUFFALO-DETROIT. *Canadian regulations have eased on flights non-stop between Detroit-Buffalo and points east that have to cross Canadian portions of the route. No Defense flight plans have to be filed if flight is over or south of Green 2 or Red 22. If planning to fly or forced to detour north of these airways, you must file.*

DALLAS-FORT WORTH. *Caution! Pilots landing Amon Carter airport are mistaking bright mercury vapor lights on adjacent highway for runway lights at night and in low visibility.*

FORT WAYNE, Ind. *Shut-down on VOR may extend to early September.*

NEW YORK AREA. *Cross-talk between the four metropolitan airports and their traffic on 121.9 mc common Ground Control frequency may force at least one major airport off the frequency to an alternate for safety. Near collision due to pilot tuning wrong tower on approach also may force one tower primary VHF out of the crowded 118 band.*

PITTSBURGH, Pa. *Decommissioning of TYRONE radio beacon (E course PIT-NE course Altoona) on Red 21 may be first step in re-alignment of the Pittsburgh area which includes shifting of PIT courses and airways.*

HARRISBURG, Pa. *Early commissioning of the ILS may follow temporary installation of old-style Glide Path in lieu of new CAA-type giving site trouble.*

WILLIAMSPORT, Pa. *This airport trying hard for an ILS installation to lower present very high minimums forced by unfavorable terrain. If literal straight-in approach to any runway is impractical, runway configuration is such that an ILS course to center of airport with less than 30 degrees turn to land might lower ceiling minimum if climb-out requirements can be met. Next best solution—build new airport in flat river valley south of ridge near Montgomery.*

RADAR. *Norfolk and Pittsburgh in operation.*

VOR'S. *A new site for Caldwell, N. J., relocation not yet announced after postponement of change. TVOR planned for Roanoke, Va., may not lower minimums but will considerably aid approach problems. The Navy VOR at Patuxent River, Md., (NHK) is not commissioned for civil use.*

Monitoradio Now Covers All Civil VHF Channels

One of the problems of many sections of the operations phase of the aviation industry has been the need to keep intimately informed on such details as locations of company-owned aircraft, take-off and landing times for company use and other operational information.

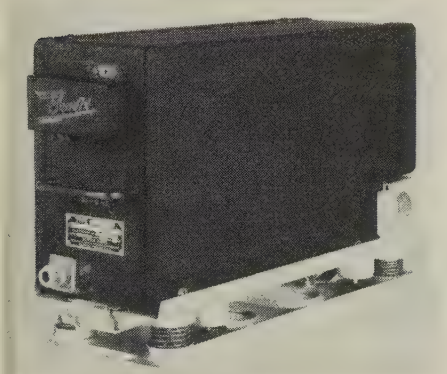
Many corporation, commercial and private pilots are familiar with the little home-style radio receiver in so many commercial field offices where a constant guard is maintained on a local area Weather Bureau aviation broadcast. Much more complicated and expensive

HF receivers were needed, if it was lesired to listen to tower, radio range HF broadcasts, ground control, approach control, and communications of heir aircraft to any or all of the above.

The Monitoradio AR-4 receiver tunes 108-136 mc, covering all civil VHF channels in that spread. The AR-5 covers 118-149, omitting ILS and VOR channels but including many Air Force channels, amateur and Civil Air Patrol. Aside from the obvious uses to flying schools, local base operators, etc., are the advantages to field supervisors, service men, freight and baggage handlers and all executive, administrative and operating personnel in keeping alerted constantly to immediate or pending demands in their sphere of operations. Price of the two units is $66.50 each at Radio Apparatus Corporation, 55 North New Jersey St., Indianapolis, Ind.

Bendix Markets New Glide Slope Receiver

The Radio Division of Bendix Aviation Corporation has announced a new 20-channel ILS glide path receiver, the MN-100A, in the 329.3 to 335.0 mc. band. The receiver weighs less than 13 lbs. and is mounted in a ½ ATR housing. It has a shock-mounted base, with removable side plates for easy accessibility and rear plug connector.



BENDIX *20-channel (329.2 to 335 mc) glide slope receiver weighs less than 13 pounds*

Frequency selection is accomplished by means of a VOR localizer glide path control selector, also used in conjunction with Bendix NA-5 DME. The receiver will operate the horizontal pointer of one to three standard cross-pointer indicators to provide a continuous visual indication of the position of the aircraft with respect to the established glide path of the standard 90/150 cps tone-modulated glide slope ILS systems. High selectivity and sensitivity plus low radiation, allowing simultaneous operation of two receivers on a common antenna are claimed.

The high-voltage power supply is built into the receiver and requires 115-volt 320-1750 cycle AC at .25 amps. It also requires 26.5-volt DC at 1.1 amps for tube filament and relay supply. The entire unit is 4⅞ in. wide, 7 9/16 in. high, 13 5/32 in. deep. Rear plug Cannon DPD-32-34P.

Glide Path Receiver Tolerance Standards Revised by the CAA

In CAA Aviation Safety Release No. 374, it was revealed that glide slope receivers adjusted to tolerance standards set forth in an earlier RTCA Paper for Model R-89 receivers had been considered acceptable for all types receivers, but that it was recently determined that these tolerances would not, in all cases, provide full-scale needle deflection in aircraft operating at the lower outer limits of the glide path pattern.

Although the Civil Aeronautics Administration recommends that the "fly-up" segment of the indicator should be avoided by pilots under actual ILS approach conditions at all times, less than full scale deflection under previous standards could be misinterpreted as "below but within safe limits" operation with subsequent disastrous results.

Therefore, it is recommended that:

A. RF Sensitivity

With a signal input of 140 mv, the output current in one of a three-indicator load should not be less than 50 ma on all channels.

B. Course Sensitivity Adjustments

1. On a 700-mv input with modulation 40% of 90 cycles, 40% of 150 cycles, and a 2 db ratio, the current in each indicator of a three-indicator load should be 78 ma with tolerances of plus 2, minus 3 ma.

2. With a 14000-mv input with modulation 40% of 90 cycles, 40% of 150 cycles and a 2 db ratio, the current in each indicator should be 78 ma with tolerances of plus 2, minus 8 ma.

C. Flag Current Adjustments

With a standard two-flag load, the total flag current should be adjusted to 700 ma with tolerances of minus 0, plus 200 ma. This adjustment should be made with a signal input of 700 mv, 0 db ratio and with 40-40% modulation.

If it is necessary to modify the receiver to provide variable flag current control, the manufacturer should be consulted to ascertain if CAA approval of the modification has been obtained, to avoid invalidation of the receiver CAA type certificate.

Use of the foregoing procedures will assure compatibility of the airborne equipment with ILS ground facilities and will provide a "hard bottom" to the glide slope with little increase in needle sensitivity.

SKYWAYS FLIGHT OPERATIONS ROUND TABLE

Skyways Round Table

(Continued from page 23)

haven't had comments here from someone who has found a lot of error in omni. I'm sure some error that Art hasn't caught exists at some spot out in space. The VOR system is keyed to give the greater accuracy where the user requires it.

"I believe you make some radial flight checks, too, don't you, Art? The combination of orbital checks and the radial checks on VOR stations before they are designated in the Victor Airways is pretty thorough."

Arthur E. Jenks: "That's right."

Cole H. Morrow: "Has anyone ever conducted any tests that would give us the comparative accuracies of LF ranges vs. VOR's? If we have been using LF ranges all this time and they have a certain error, then that establishes a parameter by which we can evaluate the VOR."

Arthur E. Jenks: "One of the things that I'm quite rabid on is the finger of suspicion that is pointed at anything new. We've got two schools of thought: we have the real veteran of the airlines who broke into IFR flying with the old four-course range and who had to know orientation procedures backwards and forwards plus upside down; and we have the newer school of pilots who've had to go through the motions of this sort of procedure but who never have had to use it because they always have had a DF or an ADF or something else that pulled them out of a jam when it came to orientation.

"Based on system accuracy, a lot of pilots know a low freq. range is only as good as your antenna system and your receiver installation on any particular aircraft, plus your own interpretation of what you hear. Now, there is a group of variables that can add up to something preposterous at times and through no fault of the individual trying to use it, particularly with intersections. A certain antenna on a certain aircraft can shove that intersection seven or eight miles one way or another. Yet everybody will religiously report over a certain point as though he were actually right there instead of where he actually is, merely within range of the point.

"We have similar errors with VHF, but we're trying to correct them. We do get some course pushing, but if you dig into the situation, you'll find in most cases that it's the result of being outside the service area of that facility or too low an altitude. That's one reason why we don't want pilots to 'barnstorm' in the outer limits of the VHF facility. You can get into trouble doing that, and perhaps quicker than you would using low frequency.

"As for accuracy on DF bearings on low freq., that's another sore spot with me. A particular bearing that is indicated lines up beautifully with a range; you sit and watch that bearing and hold a precision heading, and in rough terrain you watch the needle swing 8° or 9° but it's very little movement on the dial. If you watch that same thing on a cross pointer indicator with a VOR system, the needle swings halfway from peg to peg, and you throw up your hands and say, 'This is totally unusable.' Yet on the DF the same displacement is perfectly acceptable."

Frank C. White: *"Don Stuart, can you comment on the question Cole Morrow raised?"*

Donald M. Stuart *(Dir., TDEC, CAA)*: "Some years ago I spent a good bit of time in detailed checking of low frequency ranges. I certainly don't want to put LF ranges on the pan because I think they served a very useful purpose and have done an outstanding job, but I've seen many LF ranges with an arc of 25° in which you couldn't determine whether you were to the right or the left of course because the letters were either interchanged or on some courses the same letter was on both sides.

"One statement that was made at the opening of this discussion I'd like to register disagreement with, and that was that the omnirange is more complicated than the LF range. I don't believe that to be the case. As far as ground equipment is concerned, I think the LF range is considerably more complicated and much more difficult to monitor than the omnirange."

Frank C. White: *"Actually, we can't and do not continuously monitor an LF range."*

Donald M. Stuart: "We have done it, but it is very difficult and complicated. You have to go out several miles from the station to do it."

Frank C. White: *"Of course, monitoring of the VHF range is in itself a very tricky deal, but you do have the opportunity with the VHF system to monitor it 24 hours a day, and you thereby guarantee to the public that the station is within the published accuracy. If it isn't, it isn't on the air."*

Capt. J. D. Smith *(Capital Airlines)*: "So far all this discussion has been on the accuracy of VOR. From an airline pilot's standpoint, we're sold on VOR for many other reasons. All we want is to get it, and the sooner the better.

"I think another great benefit from VOR is that it considerably reduces pilot fatigue, particularly for the airline pilot flying continuously. With VHF, now that we have VHF company frequencies, we don't have to sit and listen to static for six or seven hours. You turn on your VOR receiver, identify, and that's it."

Frank C. White: *"I'm glad you brought that up, J. D. I was going to invite comment on the use of VOR under conditions of precipitation static and thunderstorm static."*

Capt. Edw. F. Harrington: "I'd like to bring up the subject of direct high-altitude operation. With an ADF facility off airways, it is practically useless and yet, with VOR, you can really navigate through thunderstorm areas. Another thing, flying at medium or high altitudes as we are now, you are in snow and ice static a great deal more than we ever were before. This is especially true above 15,000 ft."

Frank C. White: *"Capt. Harrington, have you ever observed a situation where the precip static from ice crystals or the thunderstorm static rendered VOR inoperable?"*

Capt. E. F. Harrington: "I have seen it, but only for very short lengths of time and it has never affected the conduct of the flight. The VOR would be out for only a couple of minutes."

Frank C. White: *"Were you at some considerable distance from the station?"*

Capt. E. F. Harrington: "Maybe 50 or 60 miles at 15,000 or 20,000 feet, and the outside temperature around zero degrees centigrade."

Frank C. White: *"That's a perfect situation for precip static and static discharge. I made an interesting observation regarding VOR operation under conditions of heavy static two summers ago. We were operating a P2V4 probing thunderstorms using airborne radar. The airplane, operated by the U. S. Navy, was equipped with an ARC omni receiver. We were using VOR navigation so we could report to ATC and get clearances whenever we crossed airways. During a probe of a particularly noisy thunderstorm, the lightning was flashing across the forward windows of the cockpit and the props were lighted up with St. Elmo's fire. We were operating on the VOR at Akron, Colorado, some 50 or 60 miles away, and VOR operation was just as solid as a rock. There was no loss of navigation information whatsoever."*

Capt. E. F. Harrington: "I think precip static is apt to knock it out more than thunderstorm static."

Frank C. White: *"That's right. It's the static build up on the aircraft and the subsequent continuous discharge that may bother VOR, not crash static."*

Tom R. Neyland *(Chief Pilot, Albert Trostel & Sons Co.)*: "I'd like to ask one of the airline captains how he finds the accuracy of the VOR at altitude, say 20,000 feet. Is it just as accurate at 20,000 feet as it is at lower altitudes? Can you get as clear cut a signal crossing a station at 20,000 as you can at 6,000?"

Capt. E. F. Harrington: "I wouldn't want to comment on crossing a station, but I know on our San Juan operation where we have to cross a certain check point for the Air Defense Command, we don't have any discrepancy with the *Constellations* flying at high altitude, but we have a great deal of trouble with the DC-4's flying at low altitude because they are trying to use DF. They can't use omni because they're too far out. The *Constellations* can use the Wilton omni and the Caldwell omni and they don't set the burglar alarm off."

Frank C. White: *"Capt. E. J. Smith, do you have any additional comments on the use of omni at high altitudes?"*

Capt. E. J. Smith: "Flying Eastbound out of Denver, high-altitude off-course routing, the first omni on our course is St. Louis. Flying at 19,000 or 21,000 feet, we have always gotten good reception, good identification, either on St. Louis or Denver, and we are never in a blind spot for that area. The run from Denver to St. Louis runs approximately 2 hours and 5 minutes and we always get good reception on one or the other. We've checked through the south leg of Akron and the south leg of Grand Island, and according to our estimates of ground speed, we figure out pretty well that we're right on course."

Frank C. White: *"Thank you, Capt. Smith. That's very good VOR performance. I believe Tom's question regarding the 'over' check has to do with the 'cone of confusion' over the omni station. That's a situation that can be corrected fairly easy. It requires replacement of the standard five-loop array of the VOR ground station with either a four-loop array or some other antenna system. That is a program that is going ahead as rapidly as funds will permit. In other words, it isn't a fundamental weakness in the omni system; it is simply that since we began the omni program we have learned a lot more about antennas, particularly omni antennas. The CAA's TDEC under Mr. Stuart has a four-loop array that will do a very fine job. It will give you good reversal over the station and give you good bearing accuracy.*

(Continued on page 40)


How many gallons, Sir?*

Skyways Round Table

(Continued from page 38)

"Coming up on an omni station and orbiting around it, there is one thing that the pilot definitely wants and that's good operation of his RMI, operating on VOR information. He doesn't get it today with a five-loop array if he's at any altitude and near the VOR station because there is this large 'cone of confusion.' We can get better antennas and we will get them, Congress permitting. It won't be too long until the situation is corrected in the terminal areas where it is more important than out in the enroute areas."

Capt. E. F. Harrington: "How big will the cone be with a four-loop array?"

Donald M. Stuart: "The present five-loop array cone starts in at an angle of about 48° above the horizontal and carries on until you get to the same angle on the other side. With the four-loop antenna that angle with the horizontal is 75°, so the actual cone is then about 30°, 150° vertical coverage and 30° of 'cone of confusion,' as it is sometimes called."

Frank C. White: *"Mr. Stuart's comments sound very conservative."*

Donald M. Stuart: "I'd say it's an arbitrary definition and the angle based on the TO-FROM indicator current is somewhat greater—practically full coverage. The cone with the four-loop array is certainly satisfactory operationally. It's better than the over indication with a four-course range."

Capt. S. C. Hoyt: "What is it now?"

Frank C. White: *"It's 90° across."*

Capt. S. C. Hoyt: "In other words, it's about twice your altitude. If you're at 20,000 feet, the 'cone of confusion' is about 40,000 feet across."

Frank C. White: *"Right—the antenna that the ATA tested at Baltimore is very similar to the four-loop array as to performance. With the small counterpoise that we had on it, I guess it actually wasn't quite as good as a four-loop array. You are evaluating that antenna right now, aren't you, Don?"*

Donald M. Stuart: "We found that the four-loop array has a little edge over the slotted cylinder on high angle characteristics."

Frank C. White: *"The two antennas are so similar it's a toss-up. The 'cone of confusion' is affected by the height of the antenna above the antenna counterpoise and the immediate terrain. We get better cones with lower antenna height. It was originally about 30 feet, wasn't it?"*

Donald M. Stuart: "Everything I have said here refers to 10 feet in height above a 30-foot diameter counterpoise. That's the standard installation, except for TVOR's which have a smaller counterpoise but do equally as well."

Art Jenks: "Everybody complains about the cone on the VOR, and how close do we use this cone on any facility? Coming up to New York, we cross over Philadelphia, and we note the time we are over the station. When the needle reverses, we look at the clock, figure the estimate, work it all out, then can't raise anybody because there are three other planes working the INSAC. Five minutes later we call and tell them we were over such-and-such at such-and-such a minute. Now over-reporting is a pretty relaxed deal, but until we have synchronized clocks doing it on a split-second basis, a minute one way or another means a heck of a lot of air space with a 300-mph airplane."

Frank C. White: *"There is a situation, Art, when the cone over the VOR station becomes important, and that's when the pilot is maneuvering near the station and wants to use his RMI like he does his ADF today. If you don't have a good cone over the station at high altitudes, the RMI doesn't give you an ADF indication, and that's what you want. But there again, it's the specific problem of maneuvering near the station. It's not a question of enroute flight or checking 'over' the station for traffic control purposes. Don, do you have any further comment on the question of the cone?"*

Donald M. Stuart: "I assume Art brought it up to light of the separation between holding patterns."

Arthur E. Jenks: "An intersection is no particular problem, but holding over a VOR station is not satisfactory. I don't like it and I try to get people to use other holding procedures that are more adaptable."

Owen F. Thomas *(Flight Operations Specialist, CAA)*: "Actually, holding over a VOR station in the lower 2,000 or 3,000 feet of altitude shouldn't be too much of a problem. When there's a higher altitude involved, it can be a problem. However, if a pilot starts his turn a little too early, this holding pattern air space area gives him 15 miles of protection on the long side. I don't think there's anything to worry about."

Capt. J. D. Smith: "I believe they have just finished some surveys on this holding pattern area and I think they decided that 15 miles isn't quite long enough."

Owen F. Thomas: "We've asked that question and haven't heard anything conclusive that it wasn't long enough. Our studies are primarily concerned with width."

Frank C. White: *"By a strange coincidence, J. D., the British who are notorious for the meticulous way they approach a problem, took very seriously this business of establishing an air space criterion which would encompass the air space required for holding. They came to the ICAO meeting at Montreal with a set of standards which they wanted to show us as the real answer to the problem. We took their holding pattern and the air space they allowed, and put it on top of the air space we allow, and the difference was so small that you wondered who was looking over whose shoulder. The two air space areas were so close to being the same that agreement on the adjustment of size was one of the simplest decisions that was reached at Montreal."*

Capt. J. D. Smith: "That's unfortunate, because all that figuring is based on the theory that everything is working right."

Frank C. White: *"CAA has observed the track that a pilot makes while holding, using radar and photographing it, and those tracks show that the pilots stay within the holding box."*

Donald M. Stuart: "We took a number of photographs out at Idlewild, and there were some pretty weird procedures!"

Owen F. Thomas: "Yes, but you took time-exposure pictures of pilots making transitions to facilities and final approaches as well as holding. Did not all that show up on the scope? I'd like to say this to Capt. Smith. The study you referred to as being completed, is still under consideration. You may be right, we may need a lot more air space for holding, but we haven't as yet had the final indication."

Capt. J. D. Smith: "The study I was referring to is out over Scotland. Scotland is a good area because quite often you have an over-running wind condition opposite to your approach area, and that's where I find out there's some concern over whether or not we have the proper size allotted to holding."

Owen F. Thomas: "This study came about when we were trying to standardize our criterion relative to procedure turn areas and holding pattern air space areas. Whether it should continue to be 10 miles on the maneuvering side, 10 miles in length, 5 miles on the non-maneuvering side, etc. It's not complete yet."

Capt. Edward F. Harrington: "Have you taken any pictures of the airplane when he's descending—really indicating and runs up on the holding fix before he expects to, and then starts his procedure turn on not much area? Doing maybe 330 mph, that first turn can be a beauty. Once he gets slowed down, there isn't any problem. He can just sit in a 30° bank."

Frank C. White: *"The suggestion has been made that we ask the pilots to slow down entering the holding pattern. There is a definite feeling among the airlines that we're entering those holding patterns with too much airspeed."*

Capt. J. D. Smith: "I agree, but when a fellow is coming in non-stop from Houston or some other place, and he starts down from 21,000 feet, he could really over-run the allocated area."

Frank C. White: *"I'd like to ask Ken Evans of Mohawk Airlines to comment on the airborne receiver part of the problem. We've talked about what the pilot sees in the way of overall system errors; we've commented on the method of checking the ground station. Ken represents an airline that is turning out good VOR receivers from its maintenance shop for their pilots to use. What do you observe, Ken, in the day-to-day checking of your VOR receivers? How good are they?"*

Kenneth R. Evans *(Supv. of Communications, Mohawk Airlines)*: "I'd like to start out by repeating an earlier statement that you made, Frank, that you can't get something for nothing. I feel that you buy accuracy and it takes a great deal of elaborate test equipment and well-trained personnel. We're pulling our receivers off the aircraft if the pilots report more than a 3° plus or minus error. We hold to less than 1¼° error in our shops, that's checking the receiver against an accurate standard. In looking over some records of the past years, I've found that we've had less difficulty with our omni receivers than we've had with our other LF equipment. Maybe that's because we are stressing our VOR more, or maybe it's just that the LF equipment is getting a little old.

"I believe that with qualified and trained personnel, you can get any accuracy you desire."

R. C. Wheeler *(Airborne Instruments Lab)*: "I think we have to remember, Frank, that the errors the airline pilots have been reporting are really not VOR station errors, as we may have called them. They are actually the *system* error which is the algebraic sum of the VOR station error and the receiver error."

Frank C. White: *"Yes, George, and we must also add the pilot's ability to be accurately*

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over the point that he thinks he's over! It's all added together when we check the system errors of VOR."

R. C. Wheeler: "That's correct. We found in the Airborne Instruments Laboratory survey that, depending on what particular azimuth we are checking, the receiver error could well be the principal error if the station error happened to be small at that particular azimuth."

Cole H. Morrow: "In your testing of VOR receivers, Mr. Evans, do you make it a practice to test the OBS along with the companion receiver?"

Kenneth R. Evans: "Not necessarily, but if we want to set up a certain definite tolerance for a particular check purpose, we set up an OBS with a receiver. Normally, however, that isn't necessary."

Frank C. White: *"In other words, Cole, remove the receiver from the aircraft as an individual unit and check it against a standard OBS or standard resolver. Then they periodically check the OBS as a separate unit. They make no attempt to keep a particular OBS with a particular receiver."*

Cole H. Morrow: "The reason I mentioned that was that we've found that the accuracy of the receiver unit can actually be increased if you put the two together and keep them together, because of the variations in the omni bearing selectors as well as receivers."

Kenneth R. Evans: "We have found that, practically speaking, it isn't a necessary thing to do. If we want the accuracy for checking our TVOR, for example, we'll set up two together. But if we can hold the tolerance within 1° or 1¼° on the receiver in the shop, we know that our receivers and OBS will be well within tolerances when back in the aircraft."

Cole H. Morrow: "It probably isn't critical where you are doing all your maintenance work on one test unit, but it is where you're having maintenance done on different units at different places. I'm bringing that up particularly for the business-plane operators. They should bear that in mind in testing their sets when they don't always have it done on the same test stand."

Frank C. White: *"In other words, a business aircraft operator who is going to have his omni receiver checked by some station that may not have an OBS that agrees exactly with the one in his aircraft, would be better off if he took the receiver and the OBS out and had them checked together."*

Cole H. Morrow: "That would also apply to the airlines that have several different maintenance stations. I think it was United Airlines that found that with a set checked at Denver one time and at Chicago another, each maintenance man was correcting the other's errors when it was actually a difference in errors of the test sets."

Frank C. White: *"That may have been true a long time ago, Cole, but today you have to get away from the business of picking special units to go with special units. I'm sure United now treats its receivers as though they were coming off a production line, and the OBS the same way, and they make no attempt to keep them together. As Ken reported, they still keep the whole system within a very good tolerance."*

George Litchford: "I wonder if it would be appropriate here to mention the calibrating facilities that the CAA has been working with. They have a few stations installed now so that while you are actually in flight, you can tune to a channel and calibrate your receiver. If the pilot has some doubt about his equipment and he's in the region of one of those calibrating signals, he has the opportunity right then and there to check his equipment."

Frank C. White: *"A good point, Ken. There are really two programs. The first is the VOR test signal program operating on either 112 or 113 mc. There are three of those in operation: one in New York, one at Chicago and one at Kansas City; others will follow. The test signal radiates a zero degree bearing all around the station. If you're in the vicinity of one of those stations, you can check your receiver.*

"Capt. Smith, what is the figure United uses before they pull receivers for checking?"

Capt. E. J. Smith: "Plus or minus 3°."

Frank C. White: *"Mohawk uses plus or minus 3°, and I believe the industry standard at this point is plus or minus 3°. If the receiver is within plus or minus 3° of the bearing the test signal is putting out, we accept it. The test signal itself isn't exactly zero degrees . . . it varies about a degree maximum.*

"The other program for checking VOR receivers is the use of published 'check points'. Recent issues of the Airman's Guide publish some 30 to 40 check points where you can check an omni receiver. These check points have been carefully established by Federal Airways. They give the pilot a specific place on the airport surface where he can check his VOR receiver."

Kenneth R. Evans: "We have a system that provides a good check of VOR receivers. We pipe our shop test signal right out to the ramp so that any pilot originating a flight at our station can check his omni before he leaves. We can set any bearing he wants."

Frank C. White: *"Now let's get to the question of the operational utility of the VOR. We may consider two questions in this category; the use of omni for enroute flight, and the use of omni in terminal areas, both for transition to ILS and for making omni approaches. Frank Thomas, would you give us a brief analysis of how we stand today on the omni program?"*

Owen F. Thomas: "There are approximately 369 VOR's commissioned as of this date and, by the end of 1955, we expect to have 489 VOR's. There may eventually be more, depending on the operational need and budget considerations. I think about 25 TVOR's will be included in this group.

"As of June 1952, it was decided to take the VOR's which formerly were integrated in the L/MF Green, Amber, Red and Blue airways system and establish a separate VOR airways system called "Victor" airways. On June 1, 1952, the first Victor airways were designated and, as of the end of Fiscal '53, we had 51,488 miles of main VOR controlled airways and 20,576 alternate VOR airways in the domestic United States. It is interesting to compare these figures with the airways mileage of our LF system. We have 65,913 controlled LF airway miles in the U.S.

"Approximately 14 domestic scheduled airlines are approved to use the VOR system. I also understand that our U.S. Flag and the Foreign Flag air carriers plan to use the VOR's installed at Frankfurt, Hamburg, Munich, Stuttgart, Amsterdam, Rome, London and Wales.

"With respect to the 369 VOR's commissioned in the U.S., the CAA has flight checked and approved approximately 250 VOR instrument approach procedures. These have been published in the Flight Information Manual and on Approach-Landing charts. Most of the emphasis, however, has been placed on designating and flight-checking new airways. We realize that a good many more airways must be designated to fully implement the over-all system. Also, more terminal area procedures must be developed and better implemented. Much work and planning is presently being carried out throughout all the CAA Regions to accomplish these programs as soon as possible. This involves setting up more transitions from VOR's to ILS', and from L/MF aids to ILS. It also requires the continuing of the VOR airways systems right into the terminal areas by including VAR's, TVOR's, ILS and, in special cases perhaps, an LF facility where we have to, in order to fill out the VOR system and makes it more useful than it has been in the past."

Frank C. White: *"That last point is a very important one because it means that you can fly Victor airways right up to the destination instead of having the Victor airway stop near the terminal. This recent change in the program is going to give the VOR and Victor airway program a definite shot in the arm. It will mean that the Victor program will not only include VOR facilities but it will also include ILS, VAR and in odd instances, L/MF facilities as well.*

"Bud Fraley, would you tell us how this will affect the New York area. The New York terminal area undoubtedly is one of the toughest to handle. You have been working on the problem of using Victor airways and omni in particular in the New York area. What can you promise us regarding the use of Victor airways?"

Harlan W. Fraley *(Airways Operations Specialist, CAA)*: "From our standpoint, it looks pretty good. We've been working to set up as many of our Victor airways as possible and as rapidly as new VOR's are installed. The VOR is a very flexible piece of air navigation equipment and we can do a lot more with it than we ever could with the conventional four-course LF system. We in the air traffic control business are in the very trying period where we have to operate during a transition period in which some aircraft have LF and some VOR.

"Our problem has been to set up a Victor airway system which will take care of not only the traffic today but the traffic that will be flying only VOR's in the future. Using that philosophy, we sometimes have to site our VOR's to provide for the ultimate VOR airway structure and, in so doing, it may conflict with our present LF airways. When that happens, we do have a certain reduction of efficiency in handling these inter-mixed flights.

"Last February we began a review of all the regions in order to estimate, in setting up the airways, what traffic would be using VOR's within the next five years. In making that study, we picked the areas offering the most congestion. It naturally followed that we would have to give priority to those areas where the most VOR traffic would be. As Mr. Thomas mentioned, we feel that getting the air route portion set up first is of primary

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SKYWAYS FLIGHT OPERATIONS ROUND TABLE

Skyways Round Table

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importance at this point if we want to handle traffic efficiently. We have ILS in our terminal areas; we still have some VAR's that we'd like to keep; we have MH facilities; we have radar, and we should be able to take care of aircraft coming into the area that are equipped with VOR only.

"But the VOR airway would definitely bring those aircraft up to a gateway from which a transition could be made to any of these landing facilities."

Capt. J. D. Smith: "Is it the policy of the CAA in implementing a Victor airways to try and maintain the minimum altitude over the general area that exists today?"

Harlan W. Fraley: "Yes, wherever possible."

Frank C. White: *"On the question of VOR reception altitudes, Frank Thomas has made a careful analysis of that. Frank, would you comment on how the MRA (minimum reception altitude) for omni corresponds to the minimum terrain clearance altitude?"*

Owen F. Thomas: "Minimum enroute altitudes of low frequency airways are predicated on clearing all obstructions within the airway by 1,000 ft or 2,000 ft in mountainous areas. Where Victor airways are concerned, we also take into consideration minimum reception altitudes between two TVOR's in addition to the obstruction clearance requirements. Thus, the minimum enroute altitudes of Victor airways are sometimes higher than the minimum enroute altitudes of the LF airways, since they include reception considerations.

"The ultimate objective of the CAA is to be able to reduce these MEA's to at least 1,000 feet above the ground; in fact, reception down to 500 feet would be desirable. This will be accomplished by adding VOR's where required, and by utilizing fixes and intersections to lower the MEA. Until such times, it may be necessary to designate Victor airways with MEA's perhaps a few thousand feet higher than the minimum terrain clearance altitude predicated on obstruction clearances. This will assure that pilots on IFR clearances will have adequate signal reception for navigation and communications purposes while operating over the Victor airways.

"Although, as I said before, the minimum enroute altitudes for the VOR airways are sometimes higher than the minimum LF airways enroute altitudes, when you consider the entire United States, you'll notice that the MEA's of the Victor airways compare favorably with the MEA's of the LF airways."

Capt. J. D. Smith: "Could we assume, for example, that it is in a mountainous terrain where these minimum altitudes are a couple of thousand feet higher?"

Owen F. Thomas: "Not necessarily. It could also happen in flat country where reception between two stations some 150 miles apart might be such that the minimum enroute altitude is set at 2,000 or 3,000 feet higher than the minimum terrain clearance altitude."

Capt. J. D. Smith: "There's where I've had complaints from pilots. It's a situation where you do have fairly good distance between two stations and yet turbulent condition exist and, because of this new airway, they lose altitude. Actually, in the higher speed aircraft they lose a couple of thousand feet, and a couple of thousand feet of the lower altitude would make quite a bit of difference—the difference between going back or going through."

Frank C. White: *"You're on the horns of a dilemma, J. D., because if you don't designate the airway, you have no traffic control. We, therefore, urge the CAA to designate a particular airway segment based on facilities 150 miles apart. Then, perhaps, we find the reception altitude is 2,000 or as much as 3,000 feet above the terrain clearance altitude. The pilot gets out there on IFR flight and he wants to descend a couple of thousand feet. All we can do today is hold him at the lowest altitude that is on the Victor airways or, in an emergency, he can descend to the terrain clearance altitude."*

Capt. J. D. Smith: "Let's take Wilkes Barre and Erie. If a pilot does descend to the lowest minimum altitude, what does he do after he gets down there?"

Owen F. Thomas: "That's one of the route segments we're talking about, where you have a long distance between two VOR's. Obviously, there is a need for another VOR in the center between Wilkes-Barre and Erie, and it just so happens that there will be a VOR there in the near future. However, because of the over-all need of the N.Y. Air Route Traffic Control to take the traffic out of New York by way of Wilkes-Barre and Erie, and bring it in by way of Allentown, there is a need for a designated Victor airway through there.

"If we go along with the policy that the minimum enroute altitude has to include the minimum reception altitude, the minimum enroute altitude between Wilkes-Barre and Erie would have to be raised to about 8,000 or 10,000 feet. With that, you'd lose a 3,000 or 4,000-foot level that should be used. Today, pilots equipped with ADF receivers are flying along that route tuned to the Bradford RBN. It appeared most practical to use the RBN in the Victor system to permit navigation and lower MEA's. So it was agreed upon recently that in exceptional cases such as this we would designate an LF facility as part of the Victor (VHF) system and publish an MEA predicated on the reception and terrain combination of the VOR and RBN and then out to the next VOR.

"We will also have to publish another MEA between Wilkes-Barre VOR and Erie VOR for the pilot who doesn't have ADF and who may want to fly that particular VOR route. The majority of the users, however, will be able to fly at the lower altitude using the LF facility in that particular area, since most are dual equipped with VOR and ADF."

Frank C. White: *"In other words, the flight will clear from Wilkes-Barre to Erie via Bradford H facility, based on the combination of the two types of facilities."*

Owen F. Thomas: "We do not anticipate going all through the United States integrating LF with the VOR. That will be done only in those unusual cases where, in order to fully implement the VOR system and make it more usable, it appears necessary or desirable to use L/MF aids as connecting links."

Capt. J. D. Smith: "What about Red 8? Will you redesignate it after you put a VOR at Williamsport—Williamsport to Brookville? Brookville has an MH now."

Harlan W. Fraley: "I've just returned from Washington where we've been working to set up the priority of installation of the VOR's that we're to get this year. This, incidentally, is to be just relocation of VOR's that we will

need for fiscal 1955. As I mentioned earlier, I think we should concentrate on the enroute airways, and via Williamsport just happens to be one of the routes that we feel is top priority. It would give us a VOR route from the New York area to the Chicago area. There would be installations at Stroudsburg, Williamsport, Marionville and Perry, and these will connect with either Litchfield or Detroit. The installation planned for Marionville will connect nicely with Butler leading into the Pittsburgh area."

Tom R. Neyland: "Going back to Mr. Jenks' remark that with an omni station you have, theoretically, 360 range legs, I'd like to know when ATC will be able to reach out on all of those legs? Today, most ATC clearances are directed along five or six airways. Are the remaining 355 range legs useless?"

Harlan W. Fraley: "They aren't exactly useless. When you get into areas such as New York or Chicago where you have numerous airports that are heavily traveled, you can't use any one VOR, even if it were located directly on the airport, to direct traffic indiscriminately out in all the various directions. To effect an efficient flow of traffic, it will always be necessary in congested areas to establish definite routes. These routes will have to be set up so that once the controller gets the pilot onto that route, whether it's via radar vectoring or whether the pilot just takes off and heads for a radial, it will not conflict with an adjacent route."

Capt. E. J. Smith: "Omni stations in the New York area haven't been placed with the idea of being able to get into LaGuardia, Newark or Idlewild, have they?"

Harlan W. Fraley: "With the exception of one —Caldwell."

Kenneth R. Evans: "We can't use Caldwell."

Harlan W. Fraley: "That's correct. Caldwell was one of the first stations set up. It was more or less experimental and, unfortunately, when VOR traffic began to build up, that particular facility was in such a site and such close proximity to the Newark area that it could not be used for anything other than departure traffic out of Newark and going to the west over Allentown. If you attempted to use it for traffic going northwest to Buffalo, it would conflict with LaGuardia departures, also Idlewild. We shoot Idlewild out over that routing via Paterson."

Frank C. White: *"The question brought up here is a very fundamental point. It's an issue that gets crowded very easily if you don't think it through thoroughly. Nobody requires VOR navigation, and I mean VOR alone to get to Idlewild, Newark or LaGuardia. In every instance, the receiver that receives VOR will work fine for VAR and ILS as well. What we have needed, however, is the airway designation to include the combination of VOR with these other facilities.*

"Therefore, the answer to the question is really this—the VOR will be combined with existing VHF facilities to give you a combination of VHF aids that will take you to your destination. When you file your Victor flight plan, you will use VOR part of the way; you'll use VAR if it hasn't already been converted to VOR; and then you'll go on ILS and land at your terminal.

"You'll be using the VHF aids in combination. We wouldn't want to hold up the designation of a Victor airway to LaGuardia, for example, until we get a VOR working at LaGuardia Airport. There is no need for that because there's a good ILS that reaches out and joins a Victor airway. What we do need, however, is the designation of the Victor airway with the other existing VHF aids. It's been a missing link in the chain."

Capt. E. J. Smith: "As far as coming into LaGuardia is concerned, wouldn't it help if Flatbush had an omni? You could come from Allentown to intercept the Flatbush omni and get onto the ILS. The way it is now, the LF has not been adequate in a thunderstorm condition, and we have had to resort to checking the omni stations to make good the route we've been cleared on."

Harlan W. Fraley: "We don't need a VOR at Flatbush. The facilities we have now and those planned don't require an omni there. We have Mattewan, as you know, down near the present VAR. Using that in combination with Allentown and then coming in to make a transition from the Mattewan VOR to LaGuardia ILS rules out any need for an omni at Flatbush."

Capt. E. J. Smith: "Isn't Mattewan a long ways away to somebody coming in over Allentown?"

Harlan W. Fraley: "You're cleared to Mattewan out of necessity because if you come in over Bellemeade and New Brunswick, you must go down to Mattewan in order to bypass the Newark holding stack for traffic operating into Newark. You can't go through

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Skyways Round Table

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this stack because we would have to reserve an altitude for you at the Outer Marker. By by-passing the area we increase the number of aircraft that we can land at Newark."

Capt. E. J. Smith: "What about direct? They have been cleared from New Brunswick direct to Flatbush."

Harlan W. Fraley: "There are times when you may be cleared direct to Flatbush. This, however, will be only when no traffic is holding at the Newark Outer Marker or you are high enough to top the stack."

Capt. J. D. Smith: "I think you'll find that when that happens, you are always above 5,000 feet, and that's where the problem comes in. It's not just the compass locator at the Outer Marker at Newark, it's that air space assigned to that holding pattern that you have to avoid."

Capt. Edward F. Harrington: "Everybody's talking about coming in, but do we have to fly a radial going out for high-altitude flight?"

Harlan W. Fraley: "Not at this time, and there's a good reason for that, too. We can't tolerate a reduction of the amount of traffic that we can handle at any time. As I said before, with an aircraft filing a VOR flight plan out of LaGuardia to Buffalo or to the West, we are forced to get him out to at least Branchville before he can make a transition to VOR. But before that time, to separate the heavy congestion of arriving and departing aircraft within the N. Y. Terminal Area, we must confine their navigation to the LF airways where the majority is operating."

Capt. Eward F. Harrington: "What I had in mind was this use of the Glen Cove climbing pattern, for instance, where you just sit in a turn all the time until you get up to 12,000 feet. If we could take-off and climb out on a radial clear of all other traffic, it would expedite departures."

Frank C. White: *"Mr. Fraley's reply to you, Capt. Harrington, concerned a specific New York area problem. What you are describing is exactly the way the VOR system can be used when you don't have congested terminal area problem, and the omni will do that job very well. Instead of climbing on a heading using the magnetic compass, you're cleared out on a radial and climb on up to cruising altitude.*

"Bill Person, have you any comments about VOR operations from a Flight Safety standpoint?"

William P. Person *(Flight Safety, Inc.)*: "We feel strongly that we'd like to see everybody understand how to check the equipment on the ground prior to take-off. Most of the pilots know how to use omni as a navigational aid, but we feel the men should know and understand checking procedures as well."

Capt. J. D. Smith: "When will sufficient equipment be available to get this VOR system really going?"

Frank C. White: *"I made a prediction at the beginning of this symposium, J. D., that by next Spring well over half of all the airline flights would be predicated on VOR. I think that once the majority of flights swing in favor of VOR, the ball is then beginning to roll downhill. There was a very interesting analysis of that problem in the May issue of SKYWAYS. It points out very clearly that so long as the majority of the users are filing and flying L/MF aids, the occasional flight that files VOR becomes the problem; and that as soon as the majority starts to file VOR, then the occasional L/MF will become the problem. So, we must reduce the use of L/MF and start filing VOR. We are very close to the full realization of making day-to-day operating use of omni."*

Capt. J. D. Smith: "There probably has been as much pressure and as much begging going on to get a VOR at Bradford as any place I know of. I believe it will take over a year from the time of approval to get the equipment, and I believe the only thing holding it up right now is the equipment. The money is available, the site has been located and approved, and now all we need is a couple of towers to get it going."

Frank C. White: *"There is equipment for Bradford. We had figured it would be on the air by this summer, but with the reorganization of CAA, there's been the natural delay that results in all facility projects from reorganization. With the current emphasis on congested areas and heavily traveled routes, you'll see a lot of omni in the places you fly, J. D. It may mean, however, that some places out in the sticks won't have omni as soon, but they too will get it eventually. Certainly, the emphasis is in the right direction—toward the implementation of the congested areas and heaviest traveled airways. This program has the full support of all the airlines and the CAA."*

Capt. J. D. Smith: "All you people in this region are doing right now is playing a checker game. You're stealing it from Peter to pay Paul. You're pulling an omni out of one place to put it someplace else."

Frank C. White: *"We're taking an omni that was allocated, not installed, to a place that happens to be out in the sticks and putting it here in the New York area. It may be a checker game, but it's a game that involves omnis all over the continental United States. It isn't only a move from Caldwell to Paterson, it's also a move from places of little or no importance to places where hundreds of airplanes fly every day. Again, I say, emphasis is in the right direction."*

Capt. Edward F. Harrington: "What is the status of TVOR?"

Frank C. White: *"The program, including fiscal '54, was approximately 30 facilities, assuming that the requested budget is approved by Congress. That program will provide TVOR's at such places as Cleveland, Detroit and terminals that require departure radios of the type you were interested in before. It also provides TVOR's for a terminal such as Utica where Mohawk Airlines runs 16 or 18 flights a day. The delivery of TVOR equipment, however, is considerably behind schedule."*

Owen F. Thomas: "The actual figures I was given yesterday read: fiscal '53—one LVOR and 11 TVOR; fiscal '54—14 TVOR, thus making a total of 25 TVOR's."

Frank C. White: *"Gentlemen, I think by this time we've probably taken SKYWAYS from cover to cover and so I will attempt to summarize our discussion of the accuracy and operational utility of the VHF omnirange with these following brief comments:*

"1. The large majority of all VOR bearings, observed in flight, will be more accurate than plus or minus 2° to 3°.

"2. The VOR provides accurate bearings during conditions of excessive precipitation static and thunderstorm crash static. Disruption of VOR reception, lasting for brief periods, may occur infrequently; for example, when flying in ice crystals at high altitude.

"3. There is a requirement for decreasing the 'cone of confusion' over VOR stations to permit use of the VOR for maneuvering near the station.

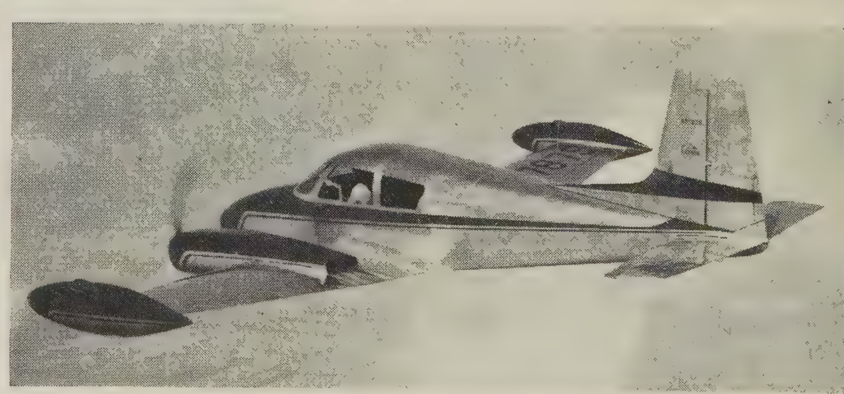
"4. Frequent checking of VOR receivers, particularly before their use for IFR flight, will assure good bearing accuracy. The VOR test signal program and the VOR checkpoints (marked on airports after check by CAA, Federal Airways) will provide increasing opportunities for conducting VOR receiver checks.

"5. A significant increase in the use of VOR (and Victor airways) for IFR flight will occur in the next six to eight months. More than half of the IFR traffic in many areas is expected to be operating on Victor flight plans by the end of that period.

"6. Increased emphasis on VOR and Victor airways for terminal area operation and heavily traveled airways will help expedite the use of VOR in areas where the requirement is the most urgent.

"7. Enthusiastic pilot acceptance of VOR is expected to continue to assure rapid growth of the VOR program.

"Thank you immensely for your individual contributions to this meeting."



CESSNA's *second Model 310 is pictured here during a test flight. Production of the new twin-engine Cessna is expected to be underway by early in 1954*

London Airport

(Continued from page 13)

here is considerable doubt as to whether hese runways will ever be built.

Just as this complex of runways has grown rom nothing, so have the approach facilities. The present radio and lighting aids as well as he operating know-how, have come a long vay from the day in early 1947 when the uthor had the problem of finding the airport one night after the loop-type range had roken down. After wandering around the sprawling, brilliantly lighted London area for some 15 minutes in a frustrated search for he field while being virtually certain that we were in the immediate vicinity of it, but with no airport in sight, it finally occurred to us to ask the tower if the field lights were on. The answer was "No", so we then requested that they be turned on. Presto, there was the field just ahead as we had suspected! Nowadays, though, those worries are over for there are, besides operating common sense, dual ILS systems, complete with markers and compass locators, GCA, VHF DF, a VOR located right at the airport, and the finest set of low and high intensity approach lights in the world, leading not to one or two runways, but to eight!

While it is really the integration of the runways, ILS, GCA, and the approach lights which makes London Airport great, let us take things one at a time starting with the ILS systems. These are oriented in opposite directions, one leading to 10R and the other to 28L. Their setups are conventional with outer, middle, and inner markers and one compass locator at the outer marker. However, the middle marker on the approach to runway 10R has been moved out from the airport slightly to give more useful information to the pilot. This marker is 4,150 feet from the runway threshold instead of the more usual 2,750 feet, with the result that it is intercepted on the glide path at 300 feet above the field elevation, instead of 150 feet to 200 feet in the usual installation. This location of the middle marker was made in accordance with recommendations of the IATA Flight Technical Group and the ICAO Operations Division and has proved so satisfactory that it will undoubtedly become the standard. The advantage is that the pilot crosses the middle marker at or just prior to reaching his minimum altitude, whereas with the old siting the marker was not crossed until at or below the field minimum. Other considerations in this relocation as listed in "Final Approach and Landing", the report on the IATA Technical Conference held at Copenhagen in May 1952, were:

"(a) an earlier distance and height check can reduce pilot distractions and attendant strain often experienced during the final phase of the instrument low approach when the tempo of cockpit activity, including visual sampling, increases sharply;

(b) an earlier distance and height check will enable pre-assessment of approach success in terms of indicated ILS displacement error; and will provide positive information as to the time remaining for correcting displacement error."

The GCA unit, though of the war-surplus type, has proven very satisfactory in actual operations. It is set up to give Precision Approaches with glide path information for runways 28L, 10R, 33L, and 05R and "Break Cloud" or PPI Approaches to the remaining runways. It is also used to position approaches from the holding facility, the Epsom range, nine miles southeast of the field. "London Director", the call of the initial positioning unit, normally picks the aircraft up as it leaves Epsom either east- or west-bound and vectors it onto the ILS where it is handed over to "London Talkdown" for the final approach. Use of "Talkdown" can be made either as a monitor for an ILS approach as normally used by the American operators, PAA and TWA, with minimums of 200 and ½, or for full GCA directions as more often used by the European carriers, some of whom have minimums as low as ¼ mile visibility. That the directors are good will be seen later from statistics on missed approaches under various visibility conditions.

Now, all of this is fairly conventional, with the exception of the dual ILS's which are conspicuously absent from the U. S. scene. It is the approach and runway lights which really make London Airport. The four Calvert high-intensity approach light layouts to runways 10R, 10L, 28R, and 28L are undoubtedly the finest in the world. I don't want to get in an argument with Ernie Cuttrel or Johnny Gill on the relative merits of the Calvert vs. the ALPA-ATA system because I've never flown the latter lights, but I daresay that there is no doubt in the mind of any pilot flying into London that the Calvert system, with its center line and cross bars, is far superior to any left-hand system, slope-line system, or two-line system now in operation. The lights are so good that a pilot complained recently that everybody was too casual and the "first string" GCA controllers didn't even go into operation until the visibility got down to about a half mile!

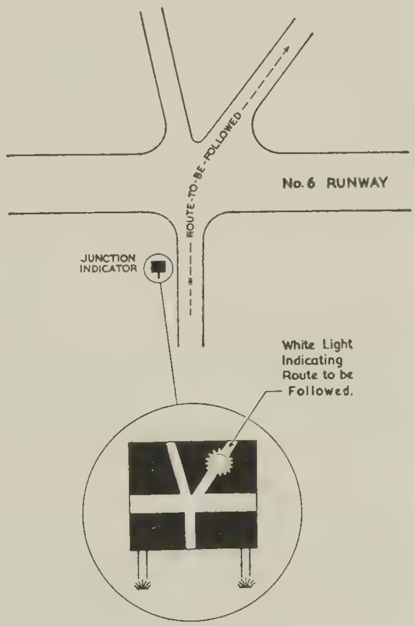


FIG 4—*Sign gives diagramatic picture of approaching intersection at London Airport*

Figure 3 is a cockpit view of the lights leading to runway 10R. The center line extends for 3,000 feet from the threshold and consists of 7,000 cp sodium vapor units. The six bars are spaced at 500-foot intervals and taper from an initial 200-foot width to 75 feet for the innermost one. A low-intensity red system with three bars is also installed for use under better visibility conditions when the high-intensity lights would be blinding.

The runway lights are 4,000 cp G.E.C. high-intensity flush lights spaced 150 feet apart in width on the 300 feet and 200 feet wide runways. These lights are possibly not quite as effective as the U.S. Bartow lights, but they do a reasonably good job with the added substantial advantage of being flush and presenting no hazard to the plane.

As an added experimental, but now probably permanent, installation on 10R are a series of 50-foot stub high-intensity bars on either side of the runway for the first 2,000 feet after crossing the threshold. The purpose of these stub bars is to give the pilot an instinctive picture of the "ground plane" under conditions of lowered visibility. Many pilots in the past have complained that crossing the runway threshold with very restricted visibility was like "flying into a dark hole", even though the runway lights were visible. The author has had several disturbing experiences of difficulty in landing after being well contact on the approach lights, with roll guidance and pitch and altitude guidance being completely lost as soon as the runway threshold was crossed. This is particularly marked when the runway is black-topped.

In his paper, "Methods of Improving Visual Guidance over the Runway when Landing in Bad Visibility", Mr. Calvert says, in speaking of the last few seconds of an instrument approach:

". . . he will find himself looking at the runway guidance pattern only. As this pattern has no transverse elements, the ground plane indication will be inadequate and possibly ambiguous, and as the pattern has no centerline, the sensitivity of the directional indications will fall off markedly as he checks the descent and levels off. He must, therefore, make a quick transition on visual indications which may be geometrically indeterminate, *i.e.* which do not by themselves enable him to know with instinctive certainty where he is in respect to the runway, where he is going, or what his attitude is with respect to the ground.

If the real situation happens to correspond with that which he has visualized during the last stage of instrument flight, then his interpretation will almost certainly be the right one, and all will be well. If owing to malfunction of the airborne or ground equipment the real situation differs substantially from that visualized, or if due to fatigue the pilot has been unable to integrate the indications presented by the instruments into a correct picture of the external world, then his interpretation may be one of the wrong ones. This is a dangerous and unstable situation in which it will be hazardous either to land or to overshoot. If there is an accident, it is unlikely that the pilot (if he survives) will be able to offer any intelligible explanation of what happened, and the cause may be put down to pilot error, without anyone suspecting that the source of the 'error' lay in the visual indications and not in the pilot."

And so, after limited trial of the stub bars on the runway at the Royal Aeronautical Establishment at Farnborough, roughly the equivalent of our NACA, they were installed at London where they have proved to be a great success. The ease and certainty which

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London Airport

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they bring to the flare out and touch down does much to contribute to the pilot's "tranquility of spirit" which the IATA Technical Conference felt should be an essential part of any operational instrument approach and visual landing system. The author can testify to their effectiveness from the first-hand experience of a successful approach and landing with a B-377 under fog conditions with a reported runway visual range of only 400 yards. During the latter stages of the approach, the entire 3,000 feet of approach lights were visible and the stub runway bars made the flare out and landing so simple that it was a shock to realize, taxiing in after leaving the runway, that there actually was only about 400 yards visibility.

With the airplane safely on the ground, the next problem is taxiing, and here again, London excells. For night guidance flush green lights spaced at 80 foot intervals are provided from the turn off point to the ramp or vice versa. These lights, under certain daylight conditions however, were inadequate and the board and light diagramatic system, *Figure 4*, was evolved experimentally. This has proved so successful that it will be installed all over the airport. The signs are simple, merely being a diagramatic picture of the approaching intersection with a brilliant light indicating which taxiway should be taken outbound This taxi system may seem somewhat elaborate, but it is striking in its superiority over anything the author has ever seen anywhere else in the world, and this includes many of the major U.S. airports. It is always frustrating to have Ground Control say "Use taxiway Charlie, the east perimeter strip, and then up runway so and so to the ramp" when none of this is identified except on a small airport diagram in the route manual. How much simpler it is for Ground Control to say "Follow the lights and boards to the ramp." This may seem a small improvement, just the fixing of a minor inconvenience, but in reality it is an important step forward for the coming jet operations where fast taxi ability is almost a necessity due to the jet's ravenous fuel consumption on the ground.

In addition to the taxi direction lights, a block system of taxi control, actuated by "tripper" sections, was originally planned. Now, however, it is felt that the job can be done better and more cheaply by a Ground Surveillance Radar and one will probably be installed when it is available, the only one in existence at the present time being at Idlewild.

The final test of these systems, of course, is how well operations can be carried out with them. In trying to assess this success, three forms of comparison can be used: 1) the total number of aircraft movements per day; 2) the interval between successive instrument approaches, *i.e.* the IFR handling capacity of the field; and 3) the percentage of successful approaches under various ceiling and visibility conditions, *i.e.* the measure of the effectiveness of the field layout and the approach and landing aids.

As for the number of aircraft movements per day, London ranks far down the list of the world's busy airports, with an average of 139 aircraft movements a day in 1952. For comparative purposes, Idlewild, which is by no means the busiest airport in the United States, had an average of 290 aircraft movements per day in 1952.

As for the interval between successive instrument approaches, the controllers at London shoot for three minutes and actually average about four. This compares with the optimum achieved interval at Washington National of about two minutes. There are several reasons for this higher interval at London. In the first place there is little pressure to achieve a shorter time for the traffic demands are not pressing, except possibly in the early morning rush of transatlantic arrivals. Even then, it is highly unusual to hold for more than 10 minutes. Secondly, there is the fact that in the interests of conservatism and safety considering the use of old GCA equipment, the minimum separation between aircraft is kept at five miles as contrasted with the three miles at Washington. Finally, there is the problem of the mixed international traffic at London. Although English is the established international aviation language, there are wide variations in the ability of other than English-speaking nationals to understand and be understood in the air. As one London Approach Controller put it, "There is nothing more frightening than to give a clearance to a plane and have the reply come back with the one word, 'Roger,' with a broad foreign accent. It leaves you wondering whether it was understood or not." So, considering that since its opening, planes of some 47 different nationalities have flown into the field, the controllers at London in the interests of safety are not pushing the time interval too much.

As might be expected from the extensive ILS, GCA, and approach light aids provided, it is in the high percentage of successful instrument approaches under minimum weather conditions that London Airport really excells. And it is in that factor that the pilots' great respect for the airport lies. Figures for the period of May-December 1951 of approach success at London Airport using GCA and the Calvert approach light system are as follows:

Met. Visibility Yards	*No. of Approaches*	*Overshoots Weather*	*% Overshoots Weather*
0— 300	43	10	23%
301— 600	142	12	8%
601— 900	144	3	2%
901—1200	117	2	2%
1201—1500	85	2	2%
1501—1800	67	1	2%

While the figures are not strictly comparable, being ILS vs. GCA, the best comparison that can be made is with the figures compiled from the CAA First Region which show the following for ILS approaches:

Airplane Type	*USWB Visibility*	*% Missed Approaches*
DC-4	½ mile	25%
	¾ mile	12%
CV-240	¾ mile	7%
DC-3	½ mile	13%
	¾ mile	7%

These figures are certainly a far cry from the 2% missed approaches at London down to a visibility of 600 yards, a little less than ⅜ of a mile, and therein lies the proof of the dove-tailed integration of the initial approach method; the dual, two-direction ILS's; the GCA; the incomparable approach lights; the stub bars on the runway; the flush runway lights; the length and width of the runways and their clear approaches; and finally, the taxiing aids that truly make London Airport the pilots' best civil airport in the world.

C-124A Simulator

(Continued from page 11)

However, the real story of the electronic simulator is its practical application in solving a substantial portion of the problem of flight crew transition and proficiency training.

The cost of such training long has been a critical item in an airline's budget and it has become more critical with each advance in aircraft speed and cockpit complexity. In the realm of transition training from one type of aircraft to a more advanced one, the problem is one of teaching a flight crew to know the location of every switch and control, to know the flight characteristics peculiar to a particular aircraft, and to react correctly as a team under a wide variety of emergency conditions. They must be taught how to fly a particular airplane, rather than merely how to fly, and the emphasis must be placed on emergency reaction time.

The use of actual aircraft, costing as much as $2,000,000 or more, for such training is fantastically expensive and time consuming. An aircraft becomes a non-revenue producing item of equipment when it is removed from a scheduled route and used to train a flight crew. Revenue losses mount alarmingly.

According to a cost analysis prepared by Curtiss-Wright, the direct cost of using an aircraft only for proficiency training of 100 DC-6 flight crews, each comprising a captain, first officer and flight engineer, is $183,750. With gross revenue figured at $1,500 per hour, the study placed the yearly revenue loss at $787,500. That is based on 525 hours of non-revenue flying.

Adding the direct cost of the flight checks and the lost revenue, Custiss-Wright arrived at $971,250 as the total cost of crew proficiency flights when the aircraft only is used.

When the aircraft and the simulator are utilized for such training, Curtiss reports that air time is materially reduced and that the direct cost of the airplane and the simulator, including five-year amortization of the simulator, drops to $106,500. That is a saving of $77,250.

But the big saving is in the reduction of revenue-time loss. When the aircraft only is used for training the revenue loss of a DC-6 is $787,500 annually. When pilot flight checks are augmented by the simulator, that revenue loss drops to $225,000. Curtiss, therefore, computes the annual increased revenue stemming from the use of the simulator at $562,500. The analysis also pegs the direct savings over a five-year period at $386,250 and the increased five-year revenue at $2,812,500.

The Curtiss report declares that the simulator can replace 60 percent of the training flight time and enables the crew to practice emergency drills which cannot be realistically executed in an airplane.

Another important contribution to air safety made possible by the simulator is its use in the study of cockpit emergency procedures. Redistribution of duties in the event of illness of a crew member in flight is an example. With the simulator, it is possible to create such a condition. The incapacitated crew member is sent out of the simulator and the remainder of the crew carries on to the end of the flight.

The simulator also can be used to test composite type cockpits in determining the

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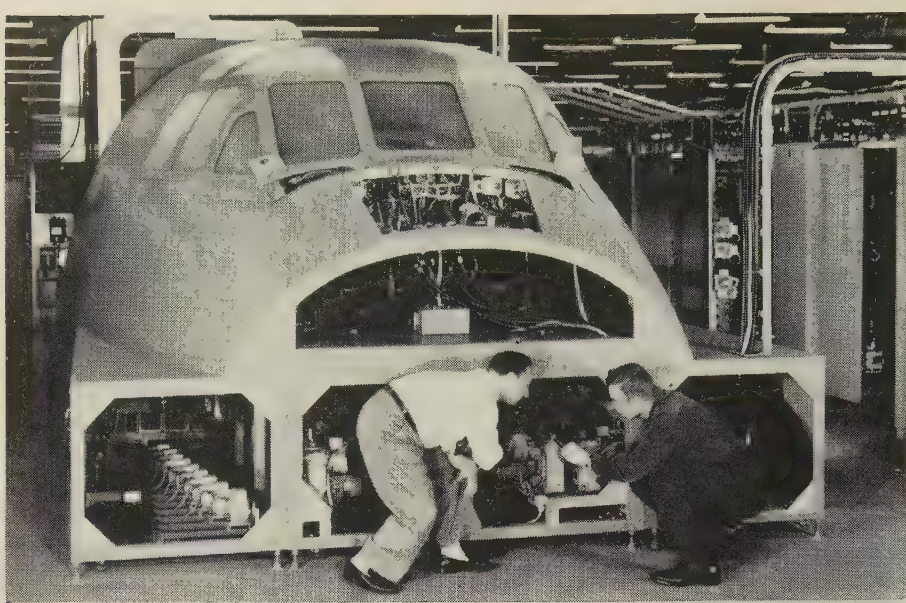


CONTROL *loading devices that give crews the "feel" of the airplane can be seen when the front panel is removed. C-124A's analog computer cabinets are on the right*

C-124A Simulator

(Continued from page 48)

arrangement in the cockpit of new aircraft designs, and it can be done at nominal cost. It is possible, too, to make the simulator a proving ground for new instruments and other equipment, thereby cutting development costs.

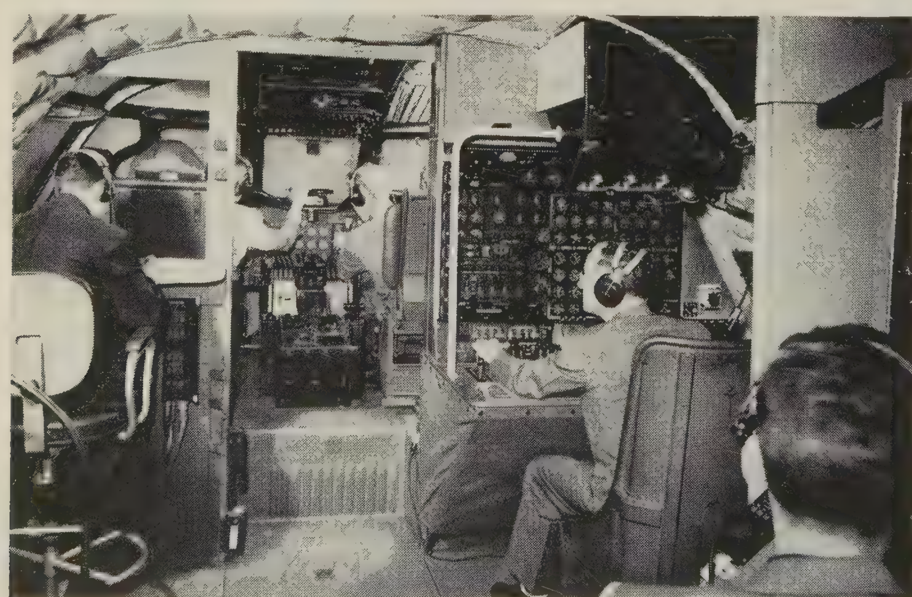
I noted earlier that all landings in simulators are completely blind. That lack of visual reference is one of the handicaps encountered in flying the simulator. Other shortcomings of the simulator are the absence of a feeling of hazard, regardless of aircraft attitude, and the lack of "G" forces.

However, these are limitations which do not detract very much from the advantages of training in the simulator. And those limitations will not always be present. It is my understanding that companies designing and building simulators are now experimenting with three-dimensional motion pictures in an effort to overcome the lack of visual reference during approaches and landings.

This 50th anniversary year of man's first powered flight might also be labeled *the* year of the electronic flight simulator. Most of the major domestic airlines, several foreign carriers and U. S. and foreign military services will be equipped with these synthetic devices by the end of the year. And out at LaGuardia Field an organization known as Flight Safety, Inc., is in its second year of offering proficiency training to a growing number of the nation's business aircraft pilots. The key piece of equipment is a Link trainer equipped with C-W's Dehmel automatic radio aids unit.

I believe the day is not far distant when flight simulators will be indispensable in the life of every airline flight crew and every business-aircraft pilot.

INTERIOR *view shows instructor at trouble console (right foreground), pilot, copilot at positions on flight deck, check pilot on high stool (left), flight engineer at right*



Simplification

(Continued from page 15)

be made as reliable as possible, and should incorporate adequate warning devices. Further, provision for mechanical override is imperative, if functioning of the system is essential to safety. Such systems must be so designed that their operation is as simple as possible, easily maintained and, insofar as is possible, "fail safe."

An example of the use of an automatic system to simplify the pilot's task, and to eliminate a recurrent "pilot error," is found in the fuel systems of most modern fighter aircraft. In the conventional fighter of World War II, fuel systems consisted of numerous individual tanks, with manual selection. Errors in the use of this type of system were common. Pilots would switch to an already empty tank instead of a full one, leave the selector in an intermediate position or, at times, allow a tank to run dry before switching.

To eliminate the possibility of such errors, the fuel systems of present-day fighters are designed so that fuel to the engine is fed from a single main tank, and the fuel from all other tanks transfers automatically to the main. With such a system, a pilot turns his fuel selector to an all-on position and, barring an emergency or malfunction, need never touch it again.

This system is obviously more complex than the old type. Transfer pumps, fuel-level control valves, and shut-off valves are needed. Provision is also needed to permit transfer of fuel to the engine directly from tanks other than the main, in case of a malfunction. It is true that malfunction of such systems have occurred. Fuel-level control valves, particularly in the early days of their development, were a persistent source of trouble. Accidents have resulted from malfunctions of this system, yet they are fewer in number than those which occurred with the old manual system. Here again, mechanical complexity has simplified the pilot's task, and eliminated a known major cause of accidents.

Harmful Complexity

The types of complexity discussed so far serve an essential purpose, in increasing the usefulness and safety of the airplane. In contrast, there is needless complexity which adversely affects reliability. Operational reliability requires not only that there be a minimum possibility of malfunction but also ease of inspection and maintenance. Needless complexity reduces over-all functional reliability and complicates the problems of maintenance. Every system must be made as simple as possible, consistent with its operational and control requirements. If a simple mechanical system will do a given job, there is no reason to install a complicated hydraulic system to do it. In one case of which the author knows, a hydraulic system involving 23 valves, many of which had to operate in sequence, was installed in an airplane to perform a function which could be performed adequately by a simple mechanical strut, operating off an eccentric. Such use of hydraulic actuation is the type of needless complexity which must be avoided. The use of an electronic circuit with its tubes, amplifiers, relays and other devices, when a direct electrical or mechanical system would serve, falls in the same category. This kind

of complexity serves no useful purpose, adds weight and cost to the airplane, decreases functional reliability and complicates maintenance.

The use of automatic controls when they do not serve an essential function is another form of needless complexity. Take, for example, a switch which should be turned on before take-off, when the pilot has plenty of time to check. If leaving the switch in "Off" position will not critically affect safety, there is no reason to provide automatic control. If, however, failure to operate the switch may precipitate an emergency at any time during the flight, either an automatic system should be installed or the pilot must be given adequate warning that the switch has been left in the "Off" position.

Emergency Systems

The same type of approach must be used in evaluating the need for duplicate emergency systems. It has been argued that any such system is needless complexity; that primary systems should be so reliable that duplication is unnecessary. Obviously, this would be the ideal state, but would imply a state of perfection not yet attained by man. Even though every effort must be made, and is being made, to make primary systems reliable, the possibility of human error in design, fabrication and maintenance is always present. Absolute reliability in systems and components cannot be expected; failures can and will occur, despite our best efforts to prevent them.

It is true that through long years of development some items of equipment have reached a point of reliability such that failures between regular overhaul periods are an extremely rare occurrence. Duplication of such items is obviously unnecessary. On the other hand, there are many systems of which this is not true. For example, in a fluid-carrying system, with its fittings and flared tube ends, there is a definite possibility of failure as a result of faulty material, fabrication or maintenance. In such cases, the consequences of failure must be carefully analyzed; if it will adversely affect the safety of the airplane or its occupants, a duplicate system for emergency operation must be provided.

There are many instances where this need is evident. The provision of an alternate power source for gyro instruments falls in this category, as the consequences of a loss of these instruments under adverse weather conditions would be disastrous. Primary flight controls involving hydraulic boost are in the same category. A failure of the primary system would mean loss of the airplane, and there can be no question as to the need for either a duplicate hydraulic system, or other means for the pilot to maintain control. To depend solely on the reliability of the primary system, no matter how carefully it is designed and maintained, would be totally unrealistic.

Most cases, unfortunately, are not as clear-cut as those discussed above, and these are the ones which become controversial. Here, a thorough analysis of all factors involved must be made to determine whether a duplicate system is necessary or would be merely needless complexity. For example, whether or not an emergency landing-gear extension system is necessary depends on whether the necessity of making a belly landing every time a failure of the primary system occurs, is accept-

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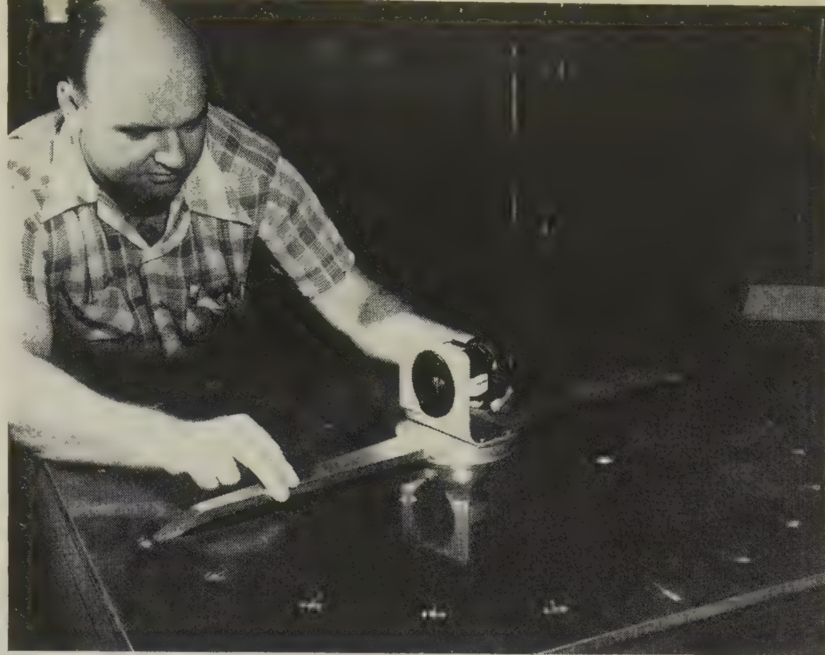


Miniature Compass Rose Devised

A short-cut in compass compensation which eliminates all error and much of the trial from conventional trial and error swinging of a compass has been devised by Temco Aircraft Corporation. Key to the simplified and improved system is a miniature compass rose, roughly one-thirtieth the size of a ramp-type rose, which is mounted on a table top. This table-top model mounts the compass and indicates whether the instrument can compensate within allowable tolerances before it is installed in an aircraft.

This check is important when the instrument is a reworked B-16 magnetic or a remote indicating compass. Reworked or aged compasses often have weak compensating magnets, air bubbles or other defects which do not permit compensation within strict military tolerances. Finding the defect before the instrument is installed saves installation time and conserves the aviation fuel usually consumed in swinging a compass. It also erases doubt, when an installed compass won't compensate, as to whether the fault is in the compass or in the aircraft structure. If the compass itself has pre-swung within tolerance, the defect obviously is a magnetic interference in the aircraft structure.

Value of this short-cut to manufacturers and large-scale operators of aircraft can be judged by its value to Temco. Most Temco-installed compasses are the reworked B-16 type. A lot of them refuse to compensate within the plus or minus 2° required on cardinal points. When a compass' value couldn't be determined until after installation, Temco specialists had two alternatives: assume the compass was defective and replace it; or blame structural interference and de-magnetize the aircraft. More often than not, the compass was at fault, and then it was necessary to install and remove compasses until an acceptable one was found. This cost time, money and manpower.

To hold down such expenditures, G. C. Hott and C. D. King mocked up their miniature rose in cardboard and wood, and began tests. Several B-16 compasses, swung and compensated on the miniature rose, checked out when installed and swung in aircraft. Therefore, Temco went ahead and fabricated a $75 production model.

The bench-type rose Temco devised is drawn on a ½ x 36 x 36-inch formica base. All compass points are drawn in to permit swinging of remote as well as B-16 compasses. An aluminum pivot pin is screwed into the base and a ½ x 6 x 32-inch aluminum pointer revolves over the pivot pin on a bronze bushing. Centered on the revolving pointer and on the rose is a bracket, interchangeable to hold either the B-16 compass or the transmitter and indicator portions of a remote compass.

Revolved, the pointer indicates on the rose the direction that the attached compass should indicate on its dial.

The rose must be directionally positioned and fixed as accurately as a conventional-type rose. Once this position is established on a permanently fixed surface, the rose itself may be removed and stored away until needed again.

Inventors Hott and King figure that one operator can swing and compensate four compasses an hour on the miniature rose. They estimate that five-to-eight man hours per aircraft are saved, thanks to the bench rose . . . and added to that saving is the savings in fuel.

Simplification

(Continued from page 51)

able. The consequences are the risk of injury to personnel, possible total loss of the airplane or, at best, the cost of major repairs and loss of use of the equipment. For a transport airplane, it is certain that the risk would not be acceptable to the public. For the military airplane, with the increased possibility of primary system failure as a result of combat damage, we cannot afford the cost, either economically or logistically. The increase in performance which would result from the amount of weight saved by omitting the emergency system is not worth the cost. Therefore, installation of an emergency extension system is required.

An analysis of all factors, such as outlined above, must be made of the need for any duplicate emergency system. If such an analysis indicates that an emergency system should be installed, every effort should be made to avoid needless complexity in the system itself. It should be emphasized, however, that in such systems the need for control simplicity, speed and reliability of operation is of greater importance than mechanical simplicity.

The design of the system must be such that no single failure can make both primary and emergency systems inoperative. One point sometimes overlooked in this regard is the possibility of a failure of the emergency system inducing a failure of the primary system. Compliance with these principles often requires added complexity.

An emergency system, installed to safeguard against one type of failure, is of questionable value if a new hazard is introduced through possible malfunction of the emergency system itself. There have been cases where mis-use of the emergency system has created such a condition. This does not necessarily dictate removal of the emergency system. Instead, an evaluation should be made of the relative severity of the hazard eliminated and that introduced, and the emergency system should be studied carefully to see whether, possibly by a slight increase in complexity, the secondary hazard cannot be eliminated.

Complexity and Progress

Much of the complexity of the modern airplane is essential to its ability to serve its purpose, and cannot be eliminated without destroying that ability. We must, in fact, be ready to accept an increasing amount of complexity of this type, if aviation is to continue to develop. For example, the problem of mid-air collision is already pressing, and with the increasing speed of airplanes, will become acute in the very near future. With increased closing speeds, the range of human vision is insufficient to give the pilot adequate warning. Since we cannot change this human limitation, we must install additional equipment, such as collision warning radar. This is only one example of the added mechanical complexity which will be inevitable, unless we are ready to say there will be no further improvement in the airplane; that we are satisfied with its present ability, speed and safety. If we are not, we must be willing to accept complexity, and place the emphasis on reliability, rather than on simplicity.

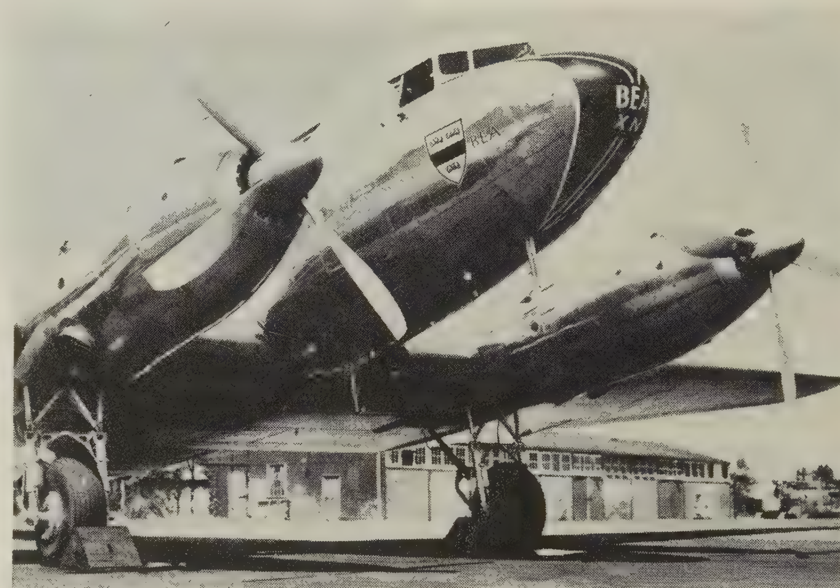
It has been the purpose of this article to indicate the complexities of the problem of simplification of aircraft and to outline some of the considerations on which any sound approach to the problem must be based.

A differentiation must be made between needless complexity and the complexity that serves an essential purpose. Needless complexity can and must be eliminated.

Complex mechanical equipment, however, is essential in the modern airplane. Its use has increased the utility and safety of the airplane and has simplified the pilot's task. Without much of this equipment, situations would often arise with which the human operator could not cope. Mechanical simplicity gained at the expense of over-complicating the pilot's task is not simplication. The primary concern must be the efficiency of the man-machine combination.

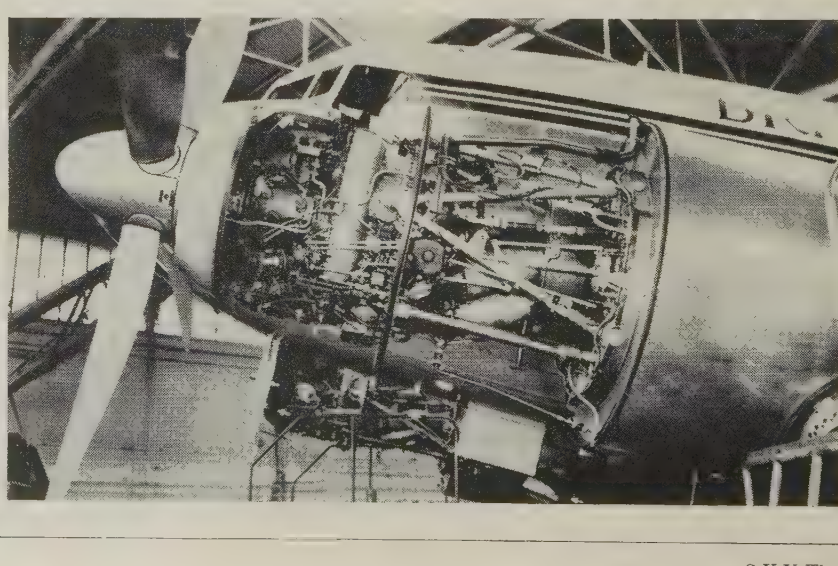
If aviation is to continue to progress, we must be willing to accept the need for mechanical complexity, and the emphasis must be on achieving reliability rather than simplicity.

"The Complexity of Simplification" is an adaptation of an address given by Mr. Stieglitz at the Air Line Pilot's Association Air Safety Forum. The talk is reprinted here with permission of ALPA.



DART-POWERED DC-3

With British interest revived in turboprop-powered airliners, attention turns to the turboprop experience British European Airways garnered in operation of Dart-powered DC-3's prior to taking delivery of Vickers Viscounts. The Dart-powered DC-3's gave BEA the experience necessary in establishing climb procedures, ground handling and engine maintenance methods related to the Viscount techniques. The Dart units extend further forward of the wing leading edge than the P&W engines, and each develops 1,547 hp plus 365 lbs jet thrust. The Dart DC-3 has normal cruising altitude of 22.000 ft, and cruising speed of 224 mph. Plane is not pressurized, so crewmen must wear oxygen masks when flying at the DC-3's operational altitude.



Business Pilot vs. Airline Pilot

(Continued from page 19)

Business Pilot	Scheduled Airline Pilot
The business pilot is not as rigidly regulated by the CAB, yet has established a safety record equal to or better than that now held by the scheduled air-carrier pilots.	The airline pilot activities are controlled by the most comprehensive regulations promulgated by the CAB and enforced by the CAA.
The business pilot usually reports to the airport two hours before departure time. The airplane must be brought to the line and undergo his personal inspection. The gasoline and oil must be checked; food, water, and coffee must be placed on board. The cabin is inspected to see that it is clean and in order for the proposed flight. Of first consideration to the business pilot is the safety, comfort, and pleasure of his passengers.	The airline pilot usually reports to the airport one hour before departure time. In the event he is unable to come, the company has time to call a reserve pilot so that the flight leaves on schedule. His airplane is taxied up to the line completely serviced by the airline's operation department. The pilot is responsible for checking the airplane, gasoline and oil. However, the stewardess handles the placement of food, coffee and water on board. All supplies are ordered by the operations department.
The business pilot must be capable of flying anywhere at anytime, with primary concern for safety, service and economy, if the aircraft is to fulfill its mission of advancing the business interests of its owner.	The airline pilot flys a prescribed route each flight and before he is eligible to fly a different route, he must cover the new route with a pilot qualified on the route and pass a CAA examination for permission to fly it. (CAR 61.113, 40.87 and 40.97). The flight schedule for the airline pilot is worked out weeks in advance.
The business pilot must go in person to the CAA office and file a flight plan, check weather conditions, and decide whether it is safe to proceed with the trip or to cancel the arrangements.	The airline pilot reports to his operations department which has on duty a CAA Certified Dispatcher and teletype equipment for recording the latest weather reports. Authority is granted to the Dispatcher to cancel any or all flights if he considers conditions unsatisfactory for safe completion. (CAR 61.191 through .218)
The business pilot has to figure the weight and balance of his aircraft. He must take into consideration the number of passengers, baggage, load distribution and the quantity of gasoline required so that the aircraft will not be overloaded on take-off and exceed the gross weight maximum approved by the CAA. *Note:* The business pilot could easily cover up over-weight on paper but recognizes that safety is his first concern. If the aircraft is overloaded on take-off and an engine fails, a safe landing is problematical. However, if under maximum gross weight on take-off, the aircraft can maintain altitude and generally effect a safe emergency landing.	The airline pilot is not held responsible for flying an overloaded airplane. The company dispatcher is charged with the determination of maximum gross weight for the airline aircraft. If an overloaded aircraft is dispatched, the Dispatcher is subject to having his Certificate suspended by the CAA. (CAR 61.154A through Q)
The business pilot must depend on CAA radio communication facilities (which are heavily used) for all positions, weather reports and Air Traffic Control clearances. If he is over the check point and a weather report is being broadcast, he has to wait until the weather report is finished before he can report his position and, sometimes, receive additional Air Traffic Control clearances and instructions.	The airline pilot has radio frequencies both day and night operated exclusively by his company. All clearances, weather and position reports are transmitted and received by the company Dispatchers. Clearances are made by telephone to the CAA.

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Business Pilot vs. Airline Pilot

(Continued from page 53)

The business pilot at the completion of his trip must close his CAA flight plan.	The airline pilot is relieved of his responsibilities by the company Dispatcher.
The business pilot at the termination of his flight must see that his passengers' luggage is unloaded, ground transportation is arranged to a hotel, and make available his telephone number so that he can be reached at any hour.	The airline pilot's duties are over at the end of his flight. All passenger baggage is unloaded by company ground personnel, and transportation is arranged by the airline operations office.
The business pilot must check his airplane, see about landing fees, arrange for servicing, hangaring, maintenance (if required), personal transportation, hotel accommodations for his crew, prepare flight records, and be on 24-hour call to return to his home base or fly to another destination.	The airline pilot turns over his aircraft to the company maintenance department and goes home or to his prearranged hotel accommodations. His next flight depends upon the schedule worked out far in advance by the Operations Department.
The business pilot, in addition to having exceptional piloting skill, must be well-groomed, have a pleasing personality and possess good personal habits. Since he is in constant contact with top officials of his organization as well as their business associates and friends, he must see to their comfort and pleasure during a trip. He permits a visit to his "office" if flight conditions are normal, and explains the operation of the airplane, its air navigation aids, etc. Prior to take-off, he explains the use of the seat belts, the no-smoking signs, what to do in turbulent air, the serving of food to passengers, the use of sick cups, etc.	The airline pilot, if he feels so inclined, walks through the cabin once during a flight and chats briefly with a few passengers. He has no personal responsibility to see to the comfort and pleasure of his passengers. It is the duty of the stewardess to take care of the needs of the passengers, serve food and refreshments, check seat belts, and see that there is no smoking during take-off and landing. The pilot seldom sees the passengers before departure or after arrival. The personal contact with passengers, which is so important to the business pilot, is almost wholly lacking on the part of the airline pilot.
The business pilot, mostly in the smaller twin-engine aircraft, frequently flies without a copilot. This requires more work in flying, particularly during landing approaches and under adverse weather conditions.	The airline pilot, in accordance with CAR, is required to have a copilot. It is recognized that flying the larger multi-engine aircraft entails more work than can be handled by one pilot.

All pilots of NBAA members are required to hold valid Commercial Pilot Certificates or higher. Most of them also hold multi-engine and instrument ratings. A large number have Airline Transport Ratings. The scheduled airlines generally require all captains to hold ATR's but do accept Commercial pilots as copilots.

In compiling these most important of the many comparisons between the business pilot and the airline pilot, it should be pointed out that they have certain common characteristics. First of all, they are required to be in first-class physical condition and this is a result of careful living habits. They must rank high in flying ability and aviation knowledge of a highly technical nature. To be a safe pilot, it takes sound judgment, initiative, mental stability and poise. In the air, as on the sea, pilots are dealing with fundamentals. Mistakes can be fatal. Long experience has taught most pilots a healthy respect for the elements and no one who faces them day-by-day can be other than humble.

Flying skill is, of course, secondary to good judgment in insuring longevity. A pilot with good judgment recognizes his ability and limitations and, when confronted with a given situation, never bites off more than he can chew.

There is an old flying adage about teaching a monkey to handle the controls of an airplane. He might be taught to fly well enough to even pass a check ride, but when the chips are down, could he exercise the good judgment and initiative so necessary to safely complete a flight? It is this reasoning ability that spells the difference between a good pilot and a statistic.

Jean DuBuque, author of this article and a veteran pilot, has been Exec. Director of National Business Aircraft Assn. for some time. Under his guidance and that of Cole Morrow, Chairman of Board, NBAA has become an organization of prime importance in the field of aviation.

Common System

(Continued from page 18)

craft and ground stations is in the region between 118 and 150 mc, with some communications still conducted in the lower frequency bands.

An amazing amount of talking between air and ground is necessary for present-day traffic control, and even the very high frequency circuits are overloaded in congested areas during instrument weather. Many pilots must use the same frequency to communicate with the ground. Only one can talk at a time without interference, and often a pilot finds the "line is busy" when he wishes to make a position report or ask for information from the ground.

One of the aims of the Common System is to develop a "private-line" between air and ground with a cockpit display which will give the pilot traffic control instructions automatically, without voice communication. The signals would be received only by the aircraft to which they were transmitted instead of only by the aircraft within range of the station. The cockpit display would include such instructions as altitude to maintain, holding fixes, and position-reporting points. The display would be constantly within view of the pilot, changing only as new instructions were transmitted from the ground.

Development of a private-line system and associated airborne displays presents many problems, and it probably will be many years before such equipment is in general use. However, it is needed now and, as air traffic continues to increase, the urgency of the need will grow.

Airborne Radar

Of all electronic marvels which grew out of World War II, radar more completely captured the public imagination than any other device. It was widely hailed as a panacea for all the ills of aviation, a cure-all which alone would solve the problems of air navigation and traffic control.

Time has demonstrated that radar is a very useful tool in both civil and military aviation. It also has demonstrated that radar has certain limitations and that its values and usefulness are different for civil and military aviation. This is particularly true of radar equipment carried aboard an aircraft, usually referred to as Airborne Radar.

If a blind man were to take a handful of tiny rubber balls and throw them straight ahead of him, one of two things would happen. If there were a wall or other solid object ahead of him, the balls would bounce back and probably one or more would strike the man. On the other hand, if there were nothing ahead of him, the balls would go straight ahead and none would return. This would tell the blind man whether the space ahead of him was clear or contained obstructions.

Radar works on the same principles. Ultra High Frequency (UHF) waves do not penetrate solid objects. Instead, they are scattered, and some of them are reflected back to the transmitting point.

A radar transmitter sends out bursts of UHF waves. Each burst lasts only a few millionths of a second, and many bursts are fired each second. After each burst has been transmitted, receiving equipment measures the time between the transmission and the "echo". The elapsed time determines the distance of the object producing the echo, in

much the same way as the Distance Measuring Equipment described earlier.

Radar transmitting and receiving antennas are highly directional. With most radar equipment, ground as well as airborne, the antenna rotates scanning a small segment of space at any given instant but covering the whole azimuth circle every second or two.

Information gathered by the radar transmitter and receiver usually is presented on a cathode-ray "scope", similar in appearance to a television picture tube. There is no picture on the scope in the ordinary sense of the word. Instead, various light patches and spots appear which can be interpreted by an experienced radar operator. Each spot represents a reflecting object from which echoes have been received, and the whole face of the scope is a crude sort of map of the area scanned by the radar.

On the scope "map", the radar location is usually the center of the display. Concentric circles show the distance in miles represented by various distances from the center of the scope. On some equipment, a 360° azimuth scale like that of a compass appears around the outer edge of the scope.

If the antenna on Airborne Radar equipment is scanning horizontally, it will pick up echoes from other aircraft within range. These will appear on the face of the scope as bright spots or "pips". The direction of the pip from the center of the scope reveals the bearing of the other aircraft, and the distance of the pip from the center of the scope measures the distance of the other aircraft from the radar.

In addition to aircraft pips, Airborne Radar will show heavy storm precipitation. This appears on the scope as a light-colored area and sometimes is so bright that it obscures aircraft pips in the storm area.

If an Airborne Radar antenna is tilted downward, the scope will tell something about the terrain below. Land areas will appear light colored, while water will appear dark. Mountain ranges and prominent ridges will show on the scope, and a skilled operator can pick out towns and cities. By using higher frequencies, the scope will show much more detail than described above over distances of a few miles.

Airborne Radar is relatively heavy. Its effectiveness depends to a large degree on the power of the transmitter. As the power is increased, the weight of the radar and associated power-generating equipment climbs rapidly. This has an important bearing on the use of Airborne Radar.

As a navigation device, Airborne Radar is much less certain and reliable than a system of radio ranges, fan markers, etc. Its usefulness is greatest in the vicinity of coastlines and other marked terrain features. It is almost useless in flat areas like the plains states and over wide bodies of water.

Aircraft flying in the continental United States, with its elaborate system of airways aids, have little need to use radar as a navigational aid. On commercial airlines, it would be pointless to carry the weight of the radar equipment solely to provide navigation information.

With military aviation, the situation is entirely different. In flying over enemy territory, and over remote areas of the Arctic, every scrap of navigational information is priceless. Airborne Radar is invaluable in military aviation, not only for direct combat purposes but for navigation as well.

Airborne Radar does have two possible applications in civil aviation, however. The most promising at the moment is use of radar to avoid storm areas of heavy, and sometimes dangerous, turbulence. At least one commercial airline is exploring the possibility of radar equipment which will show the pilot how to weave his way between severe portions of thunderstorms, thus providing the passengers with a smoother and safer flight.

The other possibility of Airborne Radar lies in preventing collisions, either with other aircraft or with mountain peaks. Due to the fact that a pilot cannot continuously watch a scope, his attention must be called by some automatic warning device when danger of collision is imminent. The warning signal must be given in time for the pilot to view the scope and take appropriate action.

Many problems are involved in the development of a suitable device. The biggest is that of scanning all the space around the aircraft. Economic reasons, such as space and weight, are also considerations. These requirements make the development of a collision-warning radar a difficult problem, but one which may be solved in time.

Radio Altimeter

The ordinary aircraft altimeter operates by measuring the atmospheric pressure, which decreases with altitude, and presenting the information in terms of feet above sea level. This atmospheric pressure differs from day to day and hour to hour, so that the altimeter readings may vary somewhat from true altitude. To offset this condition, pilots flying on instruments adjust their altimeters from time to time in accordance with barometric pressure information transmitted from ground stations.

An altimeter which operates on an entirely different principle has been developed for measuring the height of the aircraft above the terrain rather than its height above sea level. Although it is called a Radio Altimeter, it is in effect a radar transmitter and receiver pointed toward the ground. The time required for a pulse to strike the ground and return to the aircraft is measured, and the information is presented to the pilot on a simple dial graduated in feet. The instrument is highly accurate and is not affected by changes in barometric pressure.

The Radio Altimeter is a useful cockpit aid in over-ocean flying, but the barometric altimeter remains basic for instrument flying over land areas. The reason is that traffic control is based on straight-and-level flight at altitudes separated into 1,000-foot levels above sea level. If a pilot tried to fly, say 3,000 feet above the terrain, he would find himself doing some amazing acrobatics in passing over a mountain range.

The Landing Area

The devices discussed thus far have been for enroute navigation—flying the airways between terminal points. The pilot, however, is equally concerned with coming down out of the air to a safe landing. This requires additional equipment if the landing is to be made under low visibility and low ceiling conditions.

In flying along an airway, an error of a mile or so is not important, and flying 100 feet too high or too low is not particularly significant. Traffic separation is ample to protect against deviations of this magnitude.

(Continued on page 56)

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ATA *plotting display (above, center) at CAA radar traffic control center. Washington National Airport, shows the position of aircraft within a radius of 70 miles*

Common System

(Continued from page 55)

There is no such margin for error in coming down for a landing. The pilot, flying on instruments, can see nothing outside his cockpit. Yet, he must descend at a speed of perhaps 140 mph, aiming precisely for an invisible runway. The closer he gets to the ground, the more accurately he must guide his huge machine. There are three basic methods of making bad-weather approaches to an airport.

Standard Instrument Approach

The first method is called a Standard Instrument Approach. Using this system, the pilot starts from a pre-determined point, such as a Fan Marker, and begins a descent toward the airport. Sometimes, he is aided by one leg of an LF/MF Four Course Radio Range which he can follow for directional guidance or by a radio compass bearing. After the aircraft breaks out of the overcast and into the clear, the pilot completes the approach visually as he does in clear weather.

Standard Instrument Approaches can be used only when the ceiling is relatively high, the visibility good, and the approach terrain suitable. The procedure is not sufficiently precise for anything approaching all-weather operations.

ILS

The second and most widely used method of making safe approaches under low visibility and ceiling conditions is by means of a radio-beam system known as ILS. This system provides the pilot with highly precise guidance all the way down to the runway.

The ILS includes two radio transmitters on the airport which send out radio beams to the approaching aircraft. One beam, called the localizer, furnishes the pilot with left-right guidance. The other beam, called the glide slope, shows the pilot the correct angle of descent to the runway.

In the cockpit, the indications from the radio beams are presented to the pilot on a cross-pointer indicator, consisting of two needles which cross in the center of the dial. One pointer is a vertical needle, pivoted at the top, which swings pendulum-fashion right and left. At the bottom of the dial, the left side of the scale is marked with blue, the right side with yellow. It works in exactly the same way as the VOR Course Line Deviation Indicator—in fact, the same instrument generally is used for VOR and ILS navigation.

The ILS cockpit indications on the vertical needle give the pilot right-left guidance, just as in flying the VOR. If the needle moves to the right, the pilot turns slightly right to correct his heading and bring the needle back to center.

The horizontal needle of the cross-pointer indicator is pivoted at the left, and the right end of the needle moves up or down to indicate the position of the aircraft in relation to the glide slope beam. If the pointer moves above the center, the aircraft is too low, and the pilot decreases his glide to correct. Conversely, if the needle moves below center, the pilot descends to get back on the correct glide slope.

Correcting his heading and altitude as necessary to keep both needles centered, the pilot continues his approach until he breaks into the clear and can complete the landing visually.

The cross-pointer indicator dial has a warning device, consisting of two small red flags bearing the word "Off". Should the glide-slope transmitter or the localizer transmitter on the ground fail, the red flag will appear on the face of the dial. The appropriate flag also will appear if the signal is too weak to be used safely or if the receiver fails to operate satisfactorily.

The localizer transmitter operates on frequencies between 108 and 112 mc, while the glide-slope transmitter uses UHF frequencies in the vicinity of 335 mc. Each localizer frequency is paired with a corresponding glide-slope frequency. The localizer receiver is remotely controlled from a small control panel near the pilot's seat. When the pilot selects a localizer channel, the glide-slope receiver is automatically tuned to the corresponding glide-slope frequency.

Each localizer is identified by a three-letter coded designator which is transmitted at intervals. There is also a voice feature on the localizer frequency. This is used for transmitting approach control instructions from the airport control tower to the pilot.

The localizer transmitter provides an on-course signal to a distance of 25 miles or more from the airport. The width of the beam is about 70 feet at the runway, spreading to about one mile at a distance of 10 miles. The glide-slope beam, which makes an angle of about $2\frac{1}{2}°$ with the horizon, is even narrower. Ten miles from the transmitter, it is only about 1400 feet thick.

ILS Markers: It is entirely feasible to make a low-visibility approach using only the cross-pointer indicator. But several additional facilities are provided so that the pilot can double-check his position during the approach.

Two low-power fan markers, called ILS Markers, are installed with each ILS. The outer marker is located about 4.5 miles from the runway on the instrument approach path. This is modulated at 400 cycles per second and is keyed to flash the cockpit light twice each second as the aircraft passes overhead.

The middle marker is located about 3500 feet from the approach end of the runway between the runway and the outer marker. This marker is modulated at 1300 cycles per second and emits alternate dots and dashes.

Some military ILS installations have a boundary marker 300 feet from the approach end of the runway. It is modulated at 3,000 cycles per second and emits six dots per second.

The ILS Markers tell the pilot how far he has progressed toward the airport during his approach and provide a double-check on the operation of the ILS equipment. The pilot knows that, if he begins his approach from a known position and if everything is normal, he should be over the outer marker a certain number of seconds after he starts the approach. He also knows that, if he is on the proper glide slope, he will be at a certain altitude over the outer marker. If he gets the marker signal at the proper time, and is at the anticipated altitude, he can be sure that all is well. The middle marker provides a second position check.

Compass Locators: Non-directional radio beacons are installed at one of the ILS Marker sites, and sometimes at both. Used with ADF equipment in the aircraft, the Compass Locators provide a second method of checking on the progress of the aircraft toward the runway and the accuracy of the heading. The ADF needle points toward the Compass Locator as the aircraft flies in. When the aircraft passes overhead, the needle reverses its direction and points back toward the locator.

Eventually, Distance Measuring Equipment may make ILS Markers and Compass Locators unnecessary during an ILS approach. DME would have the advantage of providing continuous information to the pilot concerning his progress toward the airport instead of the intermittent information available from ILS Markers and Compass Locators.

Approach Lights: The most critical part of an instrument approach is when the aircraft breaks through the overcast and the pilot transfers from instruments to visual references for the touchdown. Under extremely low-visibility conditions, the pilot has only a few seconds to make this transition and complete the landing.

Approach Lights, extending several hundred feet from the end of the runway toward the middle marker, are provided to help the pilot make visible contact with the ground surely and accurately when he gets below the overcast. At older installations, the Approach Lights consist of 6-foot horizontal neon lights, placed 100 feet apart, crosswise to the line

of approach. They are placed on the left side of the approach path and appear to the pilot like rungs of a ladder.

High-intensity incandescent lights penetrate somewhat farther through fog, smoke, or rain than neon lights. Several types of high-intensity Approach Lights have been installed at airports in the United States, taking the place of the neon system. There is general agreement on the value of high-intensity lights but incomplete agreement as to the light configuration which is most effective. Most of those installed to date are of the left-row ladder type, using a row of incandescent lights in place of the neon bars. However, there are many proponents of a centerlane system and also of a slopeline system in which two lanes are used and the bars are installed at an angle of 45°.

The brightness of the high-intensity lights can be varied from the control tower. To be most useful, the lights must be bright enough to penetrate the overcast effectively without blinding the pilot or producing halo effects. Different brightness settings are needed for night and day use.

Ground Radar

Ground Radar operates on the same general principles as Airborne Radar discussed earlier. Radio pulses are transmitted into space. If these pulses strike a reflecting object, such as an aircraft, they are reflected back to a receiver and appear as "pips" of light on a radarscope.

Ground Radar has proved very practical for air traffic control since it provides air traffic controllers with a "picture" of all traffic within a control area. Equipment is being installed at major airports as rapidly as funds permit. Electrical power requirements and weight limitations, so important in Airborne Radar, have little significance in Ground Radar. Equipment for use at airports is effective over long ranges and can be built to high standards of reliability.

There are many kinds of Ground Radar, operating on many different frequencies, and serving a variety of specialized uses. The military services have led the way in radar development, and the types of radar used for Common System traffic control are modified and improved versions of earlier military equipment.

Four kinds of Ground Radar are, or soon will be, useful in Common System operations —Airport Surveillance, Precision Approach, Enroute Radar, and Airport Surface Detection Radar.

Airport Surveillance Radar (ASR)

The antenna of Airport Surveillance Radar rotates through 360°, and the information is presented in the airport control tower on the face of the radarscope. The antenna sweeps the whole azimuth circle about once each two seconds. Each sweep "paints" a new picture on the face of the scope, with reflection from aircraft and ground objects, such as tall buildings, appearing as "pips". Pips of moving aircraft leave faint luminous trails of light behind them, showing the direction in which the aircraft is flying and giving a clue to its speed.

Airport Surveillance Radar (ASR) has a range of 30 to 60 miles and will show aircraft flying within the terminal area. Each appears in its proper relative position on the scope. A plastic map *(Continued on page 58)*

SKYWAYS

AIRPORT SERVICE GUIDE

An up-to-date, accurate, detailed listing of aircraft services and products available to single and multi-engine operators throughout the U.S.

ARIZONA

DOUGLAS—Bisbee-Douglas International Airport. CURTIS AVIATION CO: Five hngrs, storage rates on arcrft size; tie-dwn; *CHEVRON* 80-91-100. *TEXACO & CHEVRON* oil; line svce & A&E 24 hrs; major & minor sing & multi eng, major radio & airframe, minor instru, parts for eng; wash, polish, paint, clean; *CESSNA* dealer; taxi, *AVIS* car; port of entry, arr trips Mexico; food on arprt 24 hrs; motel on arprt; weather; pilot lnge; food to go, no notice. Airport: 8 mi NW; el 4159; lat 31-28, long 109-36; no lndng fee; unicom LF 379 kc; CAA radio; field mrkng white & yellow; beacon, lights. Paved rnwys: 4, longest 7700. Charles H. Jones, Mgr, Tel 1544. Airlines: AAL.

FLAGSTAFF—Flagstaff Municipal Airport: 1 hngr, $1 under 175 hp, $1.50 over 175 hp; *STANDARD* 80-91; minor line svce, no A&E; minor single eng; *PIPER* dealer; bus, taxi, *AVIS;* weather Tel 560; food on arprt early & late; lodging Flagstaff; pilot lnge; crdt crds; food to go, delivered to arcrft on notice; closest arprt to Gr Canyon, Oak Creek Canyon. Airport: 5 mi SSW; el 7010; lat 35-08, long 111-40; hrs opera 5 a.m.-11:30 p.m.; lights, beacon. Cinder rnwy: 1, NE-SW 5300, extndng SW end 1000. F. X. Shamrell, Mgr, Tel 1164. Airlines: FAL.

TUCSON—Tucson Municipal Airport: Gen storage & T hngrs, $1.75-$2.50 daily, $17.50 up mo; no tie-dwn fee; *SHELL, STANDARD* 80-91-100-115; line svce, A&E 24 hrs; major single & multi-eng, instru, airframe; major radio off arprt; wash, polish, paint, clean; eng parts up to C-46. Dealer: *BEECH, PIPER*. Taxi, limousine, *AVIS*. US weather. Food on arprt 24 hrs; lodging Tucson, free trsp to motels, dude ranches; pilot lnge; Standard, Shell crdt crds; food to go, 1 hr notice. Airport: 6 mi S; el 2630; lat 32-07, long 110-57; no lndng fee if fuel purchased; control tr, lights, beacon; unicom 371, 118.3, 121.9; radio 338-117.1; sect cht Phoenix & Douglas. Asphalt rnwys: NE 6000, NW 12,000. Obstr: mtns 6-20 mi. Bob Schmidt, Mgr. Airlines: AAL, FAL.

CALIFORNIA

BAKERSFIELD—Kern County Airport No. 1: Hangar space for 100 arcrft, storage .005 per lb gross wt, tie-dwn .0025 per lb gross wt; *STANDARD* 80-91-100-115, *SHELL* 80-100-115; line svce 24 hrs, A&E 8 to 5; major single & multi-eng, airframe; minor radio; eng parts Hirt Co, Cook Aircraft Co, Pemberton Flying Svce. Pemberton dealer for: *CONTINENTAL, LEAR, NARCO, CESSNA, BEECHCRAFT, PIPER, FIRESTONE, GOODYEAR*. Wash, polish, paint, clean. Taxi, limousine, bus, *AVIS*. Weather, Tel 31558. Food on arprt 7 a.m.-8 p.m.; lodging Bakersfield; pilot lnge; all crdt crds; food to go, delivered to arcrft, 1 hr notice. Airport: 4.4 mi NNW; el 515; lat 35-25, long 119-02; control tr; ILS, compass locator; Los Angeles sect cht; lights, beacon. Paved rnwys: 3, longest 6000, sign on rnwy 30. Obstr: wtr tr rnwy 34. Cecil C. Meadows, Dir, Tel 8-8409. Airlines: UAL.

ILLINOIS

CHICAGO — Chicago-Midway Airport. BUTLER AVIATION, MONARCH AIR SVCE, NATIONAL AERO SVCE: Brick & steel hngrs; lmtd tie-dwn, $2 sing eng, $3 twin eng; *SHELL* 80-91-100; line svce 24 hrs, A&E 16 hrs; major sing & multi-eng, radio, instru, airframe; complete eng prts; wash, polish, paint, clean. Dealer: *P&W, WRIGHT, CONT,* all *LEAR, COLLINS & BENDIX, BEECH, STINSON, NAVION, LOCKHEED, CESSNA*. Taxi, bus, limousine, *HERTZ, AVIS*. Weather, Tel Reliance 5-4141. Food 24 hrs, lodging Chicago. Pilot lnge 2. Crdt crds. Conf room, telegraph. Airport: 9 mi SW Loop; el 618; lat 41-47, long 87-45; control tr, ILS, GCA. 24 hrs; lights, beacon. Chi sect cht. Pvd rnwys: 8, longest 5730. John Casey, Mgr, Tel POrtsmouth 7-0500. Airlines: AAL, BNF, CAP, DAL-C&S, EAL, LCA, Midway, NOR, NWA, OZA, TCA, TWA, UAL.

ROCKFORD—Greater Rockford Airport. Hngr strge, $2 sing eng, $5 multi-eng; tie-dwn $1; *SHELL* 80-87-91; line svce 5 a.m.-8 p.m. (CST), A&E 5 to 5; major & minor sing & multi-eng, airframe; minor radio; all type eng prts to 450 hp; wash, polish, paint, clean. Dealer: *CONTINENTAL, ARC, LEAR* (inc auto-pilot), *NARCO, PIPER*. Weather, Tel 5-4912; pilot lnge; Shell crdt crd; food at arprt 7 a.m.-10 p.m.; food to go, delivered to arcrft on advance notice; taxi, limousine, *HERTZ, FINLEY;* lodging, 3 hotels Rockford 5 mi S. Airport: 5 mi S; el 734; lat 42-12, long 89-05; no lndng fee; CAA comm sta; lights, beacon; Milwaukee sect cht; 24-hr oper. Paved rnwys: 3, longest 4499. W. O. Weaver, Mgr, Tel 5-0696. Airlines: BNF, OZA.

QUINCY—Baldwin Field. Clearspan hngr, fees $1.50 to $12.50; no tie-dwn fee; *STANDARD* 80-91-100; line svce 24 hrs, A&E on call; minor sing & multi-eng, airframe. Dealer: *NARCO, LEAR*. Cab, *HERTZ*. CAA weather svce, Tel 146. Food on arprt; food to go, delivered to arcrft on advance notice; pilot lnge; Standard crdt crd. Airport: 9.5 mi E; el 769; lat 39-56, long 91-11; no lndng fee; CAA arwy sta; 24 hr oper; Kansas City sect cht; beacon, lights. Paved rnwys: 3, all 5400. Frank W. Phillips, Mgr, Tel 6100. Airlines: BNF, OZA, TWA.

INDIANA

FORT WAYNE—Baer Field. LEEWARD AERONAUTICAL SVCE: No hngrs, no tie-dwn fee; *SHELL* 80-91-100; line svce 8 a.m.-6 p.m., A&E 2; minor sing & multi-eng, radio, instru, airframe; taxi, limousine, *HERTZ, AVIS;* Weather; food on arprt 7 a.m.-10 p.m.; crdt crds; food to go, 1 hr notice. Airport: 7 mi S; el 800; lat 40-59, long 85-12; no lndng fee; control tr, lights, radio, beacon; 24-hr oper. Paved rnwys: 3, longest 6200. Radio, ILS. James M. Ross, Mgr, Tel H-4258. Airlines: DAL-C&S, TWA, UAL.

IDAHO

COEUR d'ALENE—Coeur d'Alene Municipal Airport. TERMINAL FLYING SVCE: Tie-dwn no fee; *STANDARD* 80-87-91-98; line svce 7 a.m. to dark, A&E; major & minor lght eng & arcrft; major & minor airframe. Agent: *CONTINENTAL, FRANKLIN, LEAR, PIPER, AERONCA*. Wash, polish, paint, clean. Limousine, *HERTZ*, courtesy car. CAA weather. Food 2 mi from arprt 7 a.m.-11 p.m. Tourist crts, Clark House on Hayden lake. Pilot lnge. Standard of Calif crdt crds; rsrvtions for hunt, fish, boat. Food to go, delivered to arcrft 30 min notice. Airport: 6 mi NNW; el 2300; lat 47-46, long 116-49; no lndng fee; radio, unicom & VHF; Spokane sect cht; lights, beacon. Paved rnwys: 3, all 5400. Harold M. Rhodes, Mgr, Tel 384J1. Airlines: WCA. (over)

AIRPORT SERVICE GUIDE

(Continued from previous page)

IOWA

DES MOINES—Des Moines Municipal Airport —*AMERICAN AVIATION CO & DES MOINES FLYING SVCE:* Hngrs, 3 lrge; storage, $2 to $7.50 day, $17.50 to $60 mo; no tie-dwn fee unless equip used; *SHELL & STANDARD* 80-91-100; line svce 8 a.m.-5 p.m. & on call; A&E; major & minor sing & multi-eng; major airframe, minor radio, instru; wash, polish, paint, clean. Dealer: *LYCOMING* 65-135, *FRANKLIN* 150-165, *CONTINENTAL* C series-0-470-E185, *NARCO, LEAR, BENDIX* (magneto), *CESSNA, PIPER-STINSON, GOODYEAR, McCAULEY, SENSENICH.* Prts & equip for all makes listed. Taxi, limousine, *HERTZ, RUAN* rent-a-car. Weather 24 hrs, Tel 4-1673. Food on arprt 7 a.m.-10:30 p.m.; motel adjoining arprt; pilot lnge; all crdt crds. Airport: 4.5 mi SW; el 957; lat 41-32, long 93-39; lndng fee non-skeds only; cntrl tr; unicom 122.8; radio; lights; beacon; fld marker on roof. Paved rnwys: 4, longest 5700; obstr: trees N-S & NW-SE. A. E. Thomas, Mgr, Tel 3-0614. Airlines: BNF, UAL.

IOWA CITY—Iowa City Municipal Airport—*IOWA CITY FLYING SVCE:* 2 hngrs, storage $1.50 to $3; tie-dwn $.50; *SHELL* 80-87-91; line svce 7 a.m.-sundown; A&E; major & minor sing & multi-eng; minor radio, instru; major airframe; eng prts & equip; wash, polish, clean, paint. Dealer: *CONTINENTAL, LYCOMING, NARCO, PIPER.* Taxi, *HERTZ.* Weather, direct line to Cedar Rapids. Food ½ mi; motel edge of arprt; pilot lnge; Shell crdt crds. Airport: 1.5 mi S; el 661; lat 41-38, long 91-33; no lndng fee; omni 8.8 mi SW; Des Moines cht (U-6); lights, beacon. Paved rnwys: 3, longest 4300; obstr: ple line E & SE, trees NE. Robert J. Jehle, Mgr, Tel 6695. Airlines: UAL.

MASON CITY—Mason City Municipal Airport —*AIR ACTIVITIES, Inc:* 3 hngrs, $1 up nite, $10 up mo; no tie-dwn fee; *STANDARD* 80-91; line svce day hrs & on request; A&E; major & minor sing & multi-eng, major airframe, minor radio & instru; eng prts; polish, paint, wash, clean. Dealer: *PIPER, BEECHCRAFT.* Taxi, limousine, *HERTZ.* Weather, Tel 891; pilot lnge; Standard crdt crds. Airport: 6.5 mi W; el 1215; lat 43-09; long 93-19; no lndng fee; CAA comm sta, 24-hr oper; Dubuque sect cht; lights, beacon. Paved rnwys: 2, longest 5600. J. R. Mettler, Mgr, Tel 463. Airlines: BNF.

KANSAS

CHANUTE—Municipal Airport. *DICKERHOOF FLYING SVCE:* Two mtl & brick hangars, storage $1.50 to $2 nite; no tie-dwn fee; *TEXACO* 80-91; line svce 7:30 a.m. to dark, on call 24 hrs; A&E; major & minor arcft & eng, minor radio, instru; eng prts light planes. Dealer: *CONTINENTAL, LEAR, NARCO, MITCHELL, JAVELIN* (auto pilot), *AERONCA.* Wash, polish, paint, clean; taxi, crtsy car; food on field 9 a.m.-8 p.m.; lodging nearby; pilot lnge, weather, *TEXACO* crdt crds. Airport: 1½ mi SW; el 980; lat 37-40, long 95-29; Tulsa sect cht; CAA comm & range sta; Paved runways: 2, longest 4350; field name on taxi strip; beacon; Obstr. Poleline NW. Fred W. Montague, Jr., Mgr, tel 675. Airlines: OZA.

LOUISIANA

LAFAYETTE—Lafayette Municipal Airport—*PAUL FOURNET AIR SVCE:* Hngr $1.50 to $5 nite; no tie-dwn fee; *MOBILGAS* 80-91-100; line svce and A&E, daylight hrs, 15 min notice nite; major sing & multi-eng, airframe; minor radio; emrgncy eng reprs; wash, polish, paint, clean. Dealer: *CONTINENTAL* 65 to E185, *NARCO.* Taxi, car rental. Insac sta. Food on arprt 8 to 8; lodging in Lafayette; pilot lnge; Mobilgas crdt crd; food to go delivered to arcrft, notice required. Airport: 1 mi SE; el 44; lat 30-14, long 92-02; no lndng fee; unicom; radio; lights, beacon; Beaumont, N. Orleans chts. Paved rnwys: 2 longest 5000; obstr, trees E, line S. J. E. Bourssard, Mgr, Tel 8-9523. Airline: EAL.

MONROE—Selman Field—*MONROE AIRPORT SVCE:* Metal hngr, fees $1.50 up; *MOBILGAS* 80-100; line svce 7:30 a.m.-6 p.m.; A&E; major & minor sing & multi-eng, minor airframe; lmted eng prts; wash, polish. Dealer: *CONTINENTAL, NARCO, BEECH, PIPER, CESSNA, US* (tires), *EXIDE & BOWERS* (batteries). Taxi, limousine, car rental; weather. Tel 6329; pilot lnge; food on arprt 7:30 a.m.-4:30 p.m.; lodging Monroe. Airport: 4.6 mi E; el 79; lat 32-28, long 92-04; no lndng fee; radio fac; 24-hr oper; lights, beacon. Hard rnwys: 4, all 5000; use rnwys only. Shreveport sect cht. D. Curtis Seamon, Mgr, Tel 20832. Airlines: DAL-C&S, SOU.

MICHIGAN

DETROIT (Ypsilanti)—Willow Run Airport—*GREAT LAKES AIRMOTIVE:* Brick & steel hngrs, strge fees, tie-dwn fee; *SHELL* 80-91-100; line svce 24 hrs, A&E 8 hrs; major sing & multi-eng; prts for Continental series C & Jacobs; major airframe & radio, minor instru; wash, polish, paint, clean. Dealer: *CONTINENTAL* (series C & E), *COLLINS, NARCO, BENDIX, ARC, LEAR* (incl L2); *CESSNA* distributor. Taxi, bus, *AVIS;* Tel, Ypsilanti 5530; food on arprt 24 hrs; lodging Ypsilanti & Detroit; pilot lnge; Shell crdt crds. Airport: 5 mi E; lat 42-17, long 83-27; control tr, IlS rnwy 4-22; Detroit cht. Paved rnwys: 6, longest 7200; obstr, line SE; lights, beacon. Col. R. E. Miller, Mgr, Tel Ypsilanti 3220. Airlines: AAL, DAL-C&S, EAL, NOR, NWA, TWA, UAL.

MISSOURI

ST. LOUIS—Lambert Field—*REMMERT-WERNER:* 4 100x120 hngrs, transient strge $3 to $15; *SHELL* 80-91-100; line svce & A&E 24 hrs; major & minor sing & multi-eng, incl complete overhaul airframe & eng up to DC-3; executive conversions; major radio & airframe, minor instrument; wash, polish, paint, clean. Dealer: *CONTINENTAL, WRIGHT, LYCOMING, ARC, COLLINS, WILCOX, BENDIX, LEAR, SPERRY* (incl gyro), *BEECHCRAFT, DOUGLAS* DC-3 & C-47, *LOCKHEED LODESTAR, GOODRICH, GOODYEAR, FIRESTONE, KIDDE, AEROQUIP, JEPPESEN, SKYLAC, SKYDROL.* Taxi, limousine, courtesy car, *HERTZ, AVIS.* Wm. F. Remmert, Mgr, Tel CAbany 5425. Weather, pilot lnge with TV. Shell crdt crds. Food on arprt 24 hrs; lodging adjoining arprt, hotels in St. Louis; food to go delivered to arcrft on advance notice. Airport: 17 mi NW; el 540; lat 38-40, long 90-30; no lndng fee; control tr, LF, range, omni, ILS, GCA, VHF, MHF; 24-hr oper; lights. Paved rnwys: 3, longest 7800; high intensity lights N, WNW & ENE rnwys; Kansas City sct cht. David Leigh, Mgr. Airlines. AAL, BNF, DAL-C&S, EAL, OZA, SLI, TWA.

With this issue, SKYWAYS brings you another portion of a new-type directory which, for the first time, provides aircraft operators with detailed information concerning the services they can expect at the nation's airports. The listings shown here will be supplemented each month in the pages of SKYWAYS

Common System

(Continued from page 57)

often is placed over the face of the scope so that the controller can see the position of aircraft in relation to radio ranges, fan markers, etc. The position is shown in a horizontal plane only—the ASR gives no information concerning aircraft altitude.

The ASR scope presentation, with the radar location in the center, is called a Plan Position Indicator or PPI. One use for the ASR is in making what are called PPI approaches.

In a PPI approach, the controller, watching the scope, vectors the pilot by voice radio to a point where he can begin his descent toward the airport and then be guided toward a selected runway. A PPI approach can be made to any runway desired—it is not limited to the instrument runway.

The PPI presentation gives the controller no altitude information, and the pilot must watch his altimeter and rate-of-descent indications. The radar controller advises the appropriate altitude at each mile; for example:

"Three miles from touchdown, you should be at 1500 feet mean sea level."

PPI approaches are useful under conditions of reduced visibility for sequencing arrivals in orderly fashion. They reduce the number of missed approaches, since the aircraft lets down in the direction of landing and breaks out lined up with the runway. There is no need to circle below the overcast.

A PPI approach, however, is not as precise as that made by use of the Instrument Landing System. PPI approaches are limited to moderately low ceiling and visibility conditions.

The ASR serves another useful purpose in expediting departing air traffic. When time separation alone is used for aircraft leaving a busy terminal area, the number of aircraft which can depart in a given interval is severely limited. Several times as many departures can be handled safely if their progress is monitored on the ASR scope and controlled as necessary from the tower.

Precision Approach Radar (PAR)

At many ASR locations, another type of radar called Precision Approach Radar also is installed. It provides a third method of making approaches under low visibility and ceiling conditions. It is used, like ILS, for precision landings down to low minimums of ceiling and visibility.

The PAR equipment monitors the progress of an aircraft toward the instrument runway and presents the information to the controller in the tower with a high degree of accuracy and precision. Range azimuth and elevation above the ground are all presented continuously on the face of the PAR scope.

Since the PAR scans only the approach area leading to the instrument runway, it is only necessary to see 20° in azimuth and 6° in elevation. The triangular segments so scanned are expanded in presentation to occupy almost the full area of the scope face. The position of an approaching aircraft can be determined within about 20 feet in elevation, 40 feet in azimuth, and 300 feet in range when it is a mile from the end of the runway.

The traffic controller in the tower, using information derived from the ASR and PAR, can "talk" the pilot down to a landing with ordinary radio communication channels.

When the pilot comes within range of the

(Continued on page 61)

Common System

(Continued from page 58)

ASR, and asks for a PAR approach, his aircraft must first be positively identified. This is done by the controller giving turn instructions and watching the response of the aircraft on the radar screen. Once identification is established, the pilot is given a heading to fly which will put him in position for his final approach, together with an altitude assignment appropriate to terrain and traffic.

As the pilot proceeds along the given course, the controller watches the progress of the aircraft and gives any additional heading directions which may be required to maintain the desired track. The observed position of the aircraft is occasionally given, for example: "Eight miles south-southwest of the airport" or "Over the Blue Island tank."

When the aircraft nears the approach path to the instrument runway, it will come into view on the PAR scope, either roughly aligned with the final approach path or approaching it at an oblique angle. The controller now confines his attention to the PAR scope and advises the pilot, for example: "You are now on final approach for Runway 13 right, 6 miles from touchdown; do not answer further transmissions; if no transmissions are received for a period of five seconds, execute a standard missed approach procedure." This is to prevent any interruption of instruction from the controller and also to give the pilot protection in case of radio failure.

From this point on, the controller talks almost continuously. If the approach is good, he merely calls distances, for example: "Three miles from touchdown, you are on course, on the glide path." As necessary, he gives appropriate deviations and corrections, such as "Four miles from touchdown, 200 feet to the left, turn right, heading one-three-six", or "You are 50 feet above the glide path, ease it down", followed by "You are on the glide path; adjust your rate of descent."

A bearing correction is always given as a heading to which the pilot should turn—never as a number of degrees to be added to his present heading. Headings are always spoken in three digits, for example: "Zero-zero-eight." "Right" and "left" always refer to the pilot's right and left.

Monitoring ILS Approaches

The path followed by an aircraft making an ILS approach is the same as the path for a PAR approach. Where Precision Approach Radar equipment is installed, it is customary to monitor ILS approaches on the PAR scope. This gives a double safety factor, since the approach is covered by two entirely independent equipments, each checking against the other, making a practically foolproof all-weather low approach system.

When an ILS approach is monitored by radar, the pilot is given his distance from touchdown at regular intervals and told that he is on course and on glide path. If he strays a substantial distance from his proper course, he is told his position, for example, "1,000 feet left of course, correcting fast."

The monitoring service is normally provided and the pilot is advised of his position as shown on the radarscope at frequent intervals during his approach.

Automatic Approaches

The ILS glide slope and localizer beams can be used by an aircraft's automatic pilot equipment to provide an automatic approach to the airport. Equipment of this type can fly the aircraft more precisely than a human pilot. When using the automatic equipment, the pilot merely monitors the approach. At any time, he can disconnect the automatic equipment and take over manually.

Devices for automatic radar approaches based on PAR indications are in final development stages.

Enroute Radar

Experiments are being conducted with long-range military-type radar for traffic control along the airways, as well as in the vicinity of major airports. The type of radar being used for the tests is called Microwave Early Warning (MEW), somewhat modified for Common System operation. This radar has range of 70 miles and may prove useful in increasing the safe capacity of the airways along high density routes.

Airport Surface Detection Equipment

At some of the largest terminal airports, the controllers in the tower cannot see all the runways under limited visibility conditions. To control traffic safely while taxiing and during take-offs and landings, the controllers need some way of knowing the location of each aircraft, service truck, etc.

Radar specially designed for this purpose is undergoing tests of its effectiveness.

Moving Target Indicator (MTI)

As mentioned earlier, radar will pick up reflections not only from aircraft but also from ground objects within the area scanned. In some cases, this is helpful because it gives the radar information about the location of an aircraft in relation to buildings and hills. At many locations, however, the "ground clutter" makes it difficult to track aircraft.

A device called Moving Target Indicator has been developed to cancel out reflections from ground objects, displaying only moving targets on the radar screen. This is done by electronic circuits which time each pulse from transmitter to target and return. This time is stored and, if the following pulse circuit time is the same, the returns are cancelled out. If the time differs, the return is shown on the screen.

Radar Safety Beacons

The radar signal which reflects back from an aircraft is extremely weak—only a trivial fraction of the power transmitted into space by the radar. This makes detection of distant aircraft difficult, particularly if the aircraft is small or is behind areas containing rain and snow.

A device called Radar Safety Beacon is being developed to overcome this condition. This equipment consists of a small receiver and transmitter in the aircraft. Each time a radar pulse is received from the Ground Radar, the aircraft transmitter fires back an answering pulse of its own which is displayed on the radarscope. Such a signal is much more powerful than a reflected signal. Also, it can be coded to assist in identification of individual aircraft.

Next month: No. 4: How to Use the Common System from the book, "The Air Traffic Story," brought out by the Radio Technical Commission for Aeronautics.

★ CLASSIFIED ADVERTISING ★

Rates for Undisplayed Classified Advertising: 25c per word, minimum charge first 10 words $2.50, prepaid with order. Add 4 words if Box Number is included in lieu of advertiser's name and address.

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POWERS & GEORGE, Aircraft Brokers, of 475 Fifth Avenue, New York City; and, 505 North Ervay Street, Dallas, Texas, have purchasers for all types of aircraft from $2000. No charge for listing your ship for sale. Write for details, describing your airplane.

NEW PLANES FOR SALE

TAYLORCRAFT 4-place Tourist. Biggest value, biggest airplane in its class. Write for leaflet. Taylorcraft, Inc., Conway-Pittsburgh Airport, Conway, Pa.

USED PLANES FOR SALE

AERO-COMMANDERS

AERO-COMMANDERS: #142RBS is 100-hour demonstrator new October 1952. Extras. Excellent. Asking $54,000. Also; File #5S with 235 hours. All extras. Automatic pilot. Cost $80,000. Asking $70,000. Offer wanted. Apply, **POWERS & GEORGE,** 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

USED AERO COMMANDER: File 448 has 240 hours total time. Never damaged. Lear auto pilot, Lear dual ADF, Omni, Dual VHF, LF, Marker, ILS. Feathering propellers. Excellent throughout. $65,-000. MCINTIRE ASSOCIATES, Whiterock Airport, Dallas, Texas.

BEECHCRAFT

BONANZAS: 44 available. Model 35, #277QVS, has 765 hours, 79 since overhauled. Gyros. LF. Omni. Hangared. Undamaged. Excellent. $7640. Also; 1949 205HP, #856ZAS, with 50 hours since overhaul. Extra tank. Gyros. Omni. ADF. Beautiful. $10,500. Also; 1951 205HP, C-35, #585QCS, with 660 hours. Engine topped. Gyros. Extra tank. Omni. ADF. Undamaged. Hangared. Exceptional. $12,500. Consult, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

D-18-S. 1947 model with only 875 hours. NTSO engines. Hydromatics. Has divan and reclining seats. Dual instruments. RTA-1B, RA-10, Dual ARN-7 ADF. never damaged. New license. $52,000. MCINTIRE ASSOCIATES, Whiterock Airport, Dallas, Texas.

D18S TWINS: 11 available. 1946, #8001RS, has 1613 hours. Hydramatics. Gyros. Radio. $48,550. Also; painted 1946, #4ZYS, with 2825 hours, 825 since overhaul. Engines under 175 hours. Spare zero engine. Hydramatics. Auto-pilot. Good radio. Omni. $59,350. Also; painted late 1948, #8019QS, with 2800 hours. Engines 330 and zero. Lavatory. Hydramatics. De-icing. Gyros. Excellent radio. $63,500. Apply, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

STAGGERWINGS: 13 available. D17S 450HP, #945-GHS, has 53 hours since overhauled. Recovered. Gyros. Radio. $5000. Inquire, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

$2.00 CAN SAVE YOU HUNDREDS. Read our miscellaneous advertisement. Aircraft Listing Bureau, 1907 Archer, Chicago, Illinois.

BELLANCA

CRUISMASTERS: 5 available. 1951, #53ZAS, has only 175 hours. Metal Hartzell. Gyros. Omni-range. Extras. Hangared. Undamaged. Relicensed April. Bargain. $8500. Inquire, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

CRUISAIRS: 13 from $3300. November 1946, #7420JS, has 425 hours, 35 since top overhaul. Small fins. Primary blind. Aeromatic. Omni. Extras. Relicensed May. $3890. Also; November 1949, #652-ZNS, with 175 hours. Heavy gear. Aeromatic. Gyros. Radio. Undamaged. Hangared. Exceptional. $4500. Consult, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

CESSNA

170'S: 33 from $3300. 1950 metal, #990FAS, has 381 hours. Metal propeller. Primary blind. LF. Omni-range. Beautiful. $5150. Apply, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

170-A FLOAT PLANE: 2 available. 1950, #996SAS, has 300 hours. Factory corrosion-proofed. Metal propeller. Primary blind. ADF. Excellent. Bargain. $7690. Consult, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

190'S: 11 available. 1949, #936FAS, has only 290 hours. Gyros. Omni-range. Undamaged. Hangared. Bargain. $9000. Also; 1951, #104PDS, with 180 hours. Crosswind gear. Primary blind. LF. VHF. ADF. Hangared. Undamaged. $11,500. Inquire, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

TWINS: 6 from $2200. 300HP Lycoming #6940GS is exceptional Executive. 665 hours, engines 10 since factory overhaul. New -9 propellers. Spinners. Extra tank. Deluxe upholstery. Super sound-proofing. Recovered 1951. Outside baggage door. Gyros. VHF. ADF. Hangared. Undamaged. Apply, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

$2.00 CAN SAVE YOU HUNDREDS. Read our miscellaneous advertisement. Aircraft Listing Bureau, 1907 Archer, Chicago, Illinois.

CONSOLIDATED

CARGO B-24. File 446 is in process of complete remanufacture and overhaul. 650 hour airframe. Everything NTSO. Has many unusual modifications. In perfect condition. 45 day delivery. MCINTIRE ASSOCIATES, Whiterock Airport, Dallas, Texas.

ERCOUPES

ERCOUPES: 6 available. 1948, #9477TS, has 350 hours. Metal propeller. Radio. Extras. Undamaged. Hangared. $2000. Also; painted 1949 Clubair Model G, #9442RS, with 575 hours, engine 50 since overhaul. Metal propeller. Jumpseat. Omni. Extras. $2950 with Omni, $2595 without. Consult, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

EXECUTIVE TRANSPORT AIRCRAFT

FOR COMPLETE market reports of available Beech, Convair, Curtiss, Douglas, Grumman, Lockheed or other multi-engine aircraft, write or call William C. Wold Associates, 516 Fifth Ave., New York 36, N. Y., Telephone Murray Hill 7-2050.

GRUMMAN

WIDGEONS: 3 available. G44, #2867QS, has modified hull. Engines zero since top overhaul. Recovered. Reupholstered. Relicensed. Metal propellers. Gyros. Omni-range. ADF. Extras. Two spare engines. $20,000. Inquire, **POWERS & GEORGE,** Aircraft Brokers, 475 Fifth Avenue, New York City; and 505 North Ervay, Dallas, Texas.

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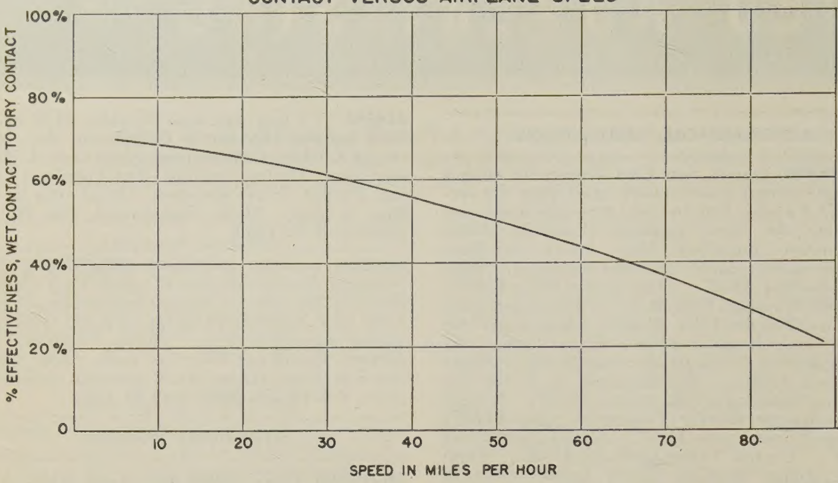
FIG. 4 PERCENT EFFECTIVENESS, WET CONTACT TO DRY CONTACT VERSUS AIRPLANE SPEED



DC-3 Take-off

(Continued from page 25)

A downhill slope also increases distance from V_1 to stop.

Temperature—The effect of warmer air (standard, 15° C.) will be to decrease the safety margin in take-off, not only in the required distance to V_1 and V_2 but also the effect on engine power and rate of climb. Similarly, a decrease in temperature will increase aircraft performance.

Gross Weight—Gross weight is the great modifier for it can be changed to conform with safety requirements. If desired performance cannot be achieved at 25,200 lbs., then the payload can be reduced. A decrease in gross weight will shorten the take-off run, the distance to V_1 and V_2, and will increase the rate of climb:

Weight	*Minimum Take-Off Distance**	*Rate of Climb—S.L.*
25,200 lbs.	855 ft.	940 fpm
24,800 lbs.	840 ft.	980 fpm
24,400 lbs.	805 ft.	1020 fpm
24,000 lbs.	780 ft.	1120 fpm

(*One airline advocates take-off at 88 mph, so V_1 and V_2 Minimum Take-off Distance, in this case, is the same.)

Performance—There are many pitfalls an executive DC-3 pilot must avoid, and he should know the following:

1. There is a loss of horsepower with service time since overhaul.
2. Wet or icy runways cut down performance on take-off.
3. Wing and propeller ice very seriously affect the take-off characteristics of an airplane. Take-offs should never be attempted with the wings covered with ice, snow or even frost, no matter how light the coating may be.
4. An unfavorable aircraft loading with a poor Center of Gravity can affect the take-off performance critically.
5. Braking action is greatly reduced by wet runways. See Figure IV.
6. The effect of rain and gusty air is hard to evaluate, but rain has a much more detrimental effect on take-off performance than on landing.
7. The DC-3 pilot who fancies himself quick on the trigger must allow himself consideration for propeller inertia distance when losing an engine. This is that small time interval that exists after the engines are cut (the take-off is to be discontinued) and before deceleration, due to the kinetic energy released by the propellers and engines as their speed decreases.

Flight Path Obstacles—The accelerate-stop distance is a minimum distance for the DC-3 when there are no obstacles in the flight path. Though the runway might be considerably longer, a limiting factor might be obstacles off the end of the runway. Minimum distance to clear a 50-foot obstacle (gross weight: 25,200 lbs.):

Altitude	*Two Engines*	*One Engine (lost at V_1)*	*Sod*	*Soft Turf*
S.L.	2040 ft.	3000 ft.	2567 ft.	3226 ft.
1000	2100 ft.	3150 ft.		
2000	2200 ft.	3250 ft.		
3000	2260 ft.	3400 ft.		

After becoming airborne the biggest safety factor is obtained from the fact that ground effect on the rate of climb increases the rate considerably over that which it is possible to achieve without ground effect.

Altitude—Engine power available and take-off performance decreases with altitude. (Decreased barometric pressure acts as increased altitude.)

Altitude	*Minimum Take-Off Distance (Accelerate only)*
S.L.	855 ft.
1000	890 ft.
2000	925 ft.
3000	960 ft.
4000	1000 ft.

It is, of course, impossible to cover every situation which may arise in the operation of a DC-3, but this is to be remembered—the DC-3 flew safely long before the Transport Category came into existence and the DC-3 was the measuring stick for the original discussions because it was the aircraft with the most complete operating record.

If this discussion of the Transport Category as related to the DC-3 has given the executive pilot a way of measuring critical take-offs, then he is enlightened. It will surely stimulate thoughts toward safer procedures in take-offs under unusual conditions.

Capt. Charles F. Banfe, Jr., who authored the article, "DC-3 Take-Off," has been an airline pilot for many years and is currently occupying the "front office" of one of Pan American Airways' Latin American Division transports. Capt. Banfe prepared this material with the cooperation of the engineering departments of Eastern Air Lines, Capital Airlines, and Pan American World Airways.